Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN ENGINEERING
FIVE DOLLARS A YEAR

DECEMBER 1954

FOUR TECHNIQUES IN
Linkage Design

Titanium Forgings

Cast-Weld Construction

Hydraulic Fluids

Evaluating Impact Loads

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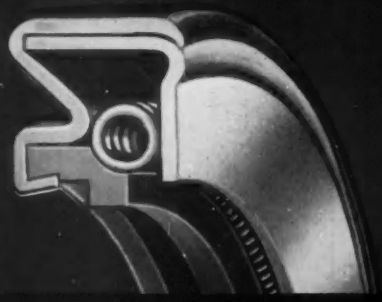
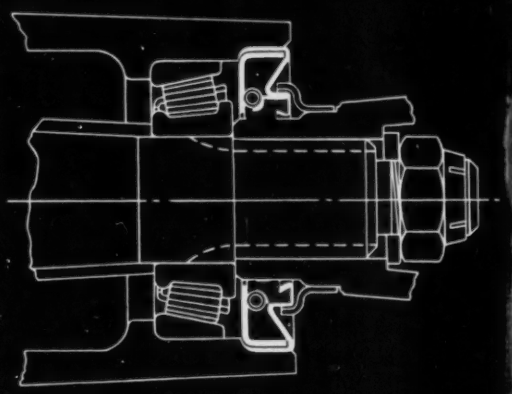
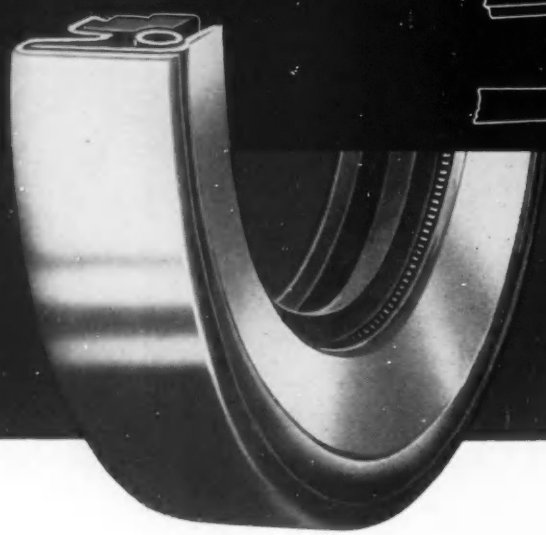


Best thing next to a bearing!





C/R Type W Oil Seal with Sirvene sealing element as applied to automotive passenger car Pinion Bearing. Note slinger arrangement for exclusion of extraneous matter.

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Chicago Rawhide brings the world's widest experience to any oil sealing problem . . . and unequalled resources of research, engineering and production. C/R's specialized sealing materials include Sirvene synthetic rubber . . . Sirvis mechanical leather . . . and the new **Conpor** leather (which gives complete lubricant control). Each of these materials offers special advantages for a wide range of applications under varying operating conditions. Chicago Rawhide engineers will be glad to work with you in developing the right material for your problem and cooperate on special designs. Or, you may be able to select the right C/R seal from 17 standard types and more than 1800 sizes. Write us, if you would like a copy of "C/R Perfect Oil Seals".

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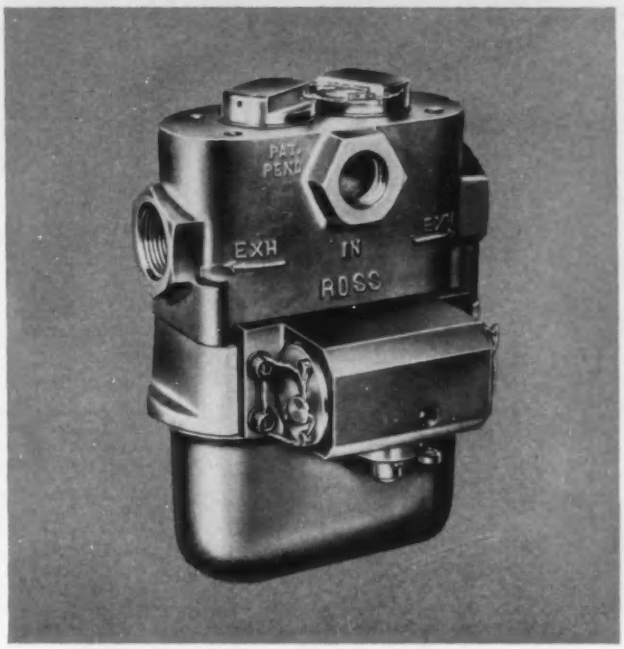

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Write for Bulletin 306

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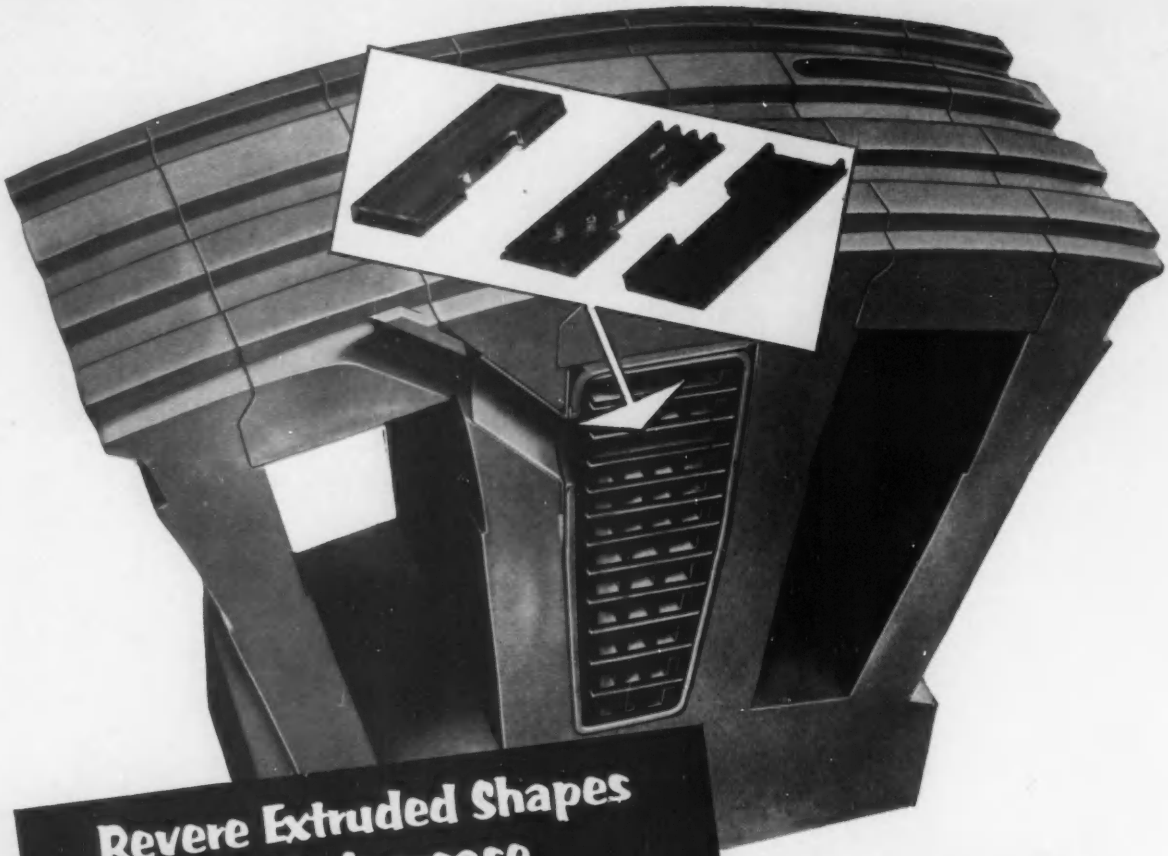

Revere Extruded Shapes help increase ELECTRIC GENERATOR OUTPUT

(perhaps you, too, could use our shapes to your advantage)

Model section of G.E. direct-cooled rotor for turbine-generator. Note intake scoop at left front, hollow copper conductors of extruded shapes, in center, exhaust outlet at right rear.

Insert shows typical extruded shapes after milling by G.E. to provide circulation of hydrogen throughout the field coils.

Winding temperatures are an important limitation upon the output of electric utility generators. They must be kept within safe limits to avoid damaging the insulation. Hence all generators have some method of cooling. Conventionally, the heat passes from the copper conductors in the rotor, through the insulation (which presents a formidable barrier to heat transfer) to the steel parts of the rotor body, and air or hydrogen is pumped through and around the rotor. It was realized long ago that more effective cooling could be obtained if some way could be found to remove the heat directly from the rotor coils.

Some years ago generator engineers of the General Electric Company, Schenectady, New York, proposed making each turn of the rotor coils of two copper extruded shapes; one a channel, the other comb-like. Fitted together, they would make hollow passages for the hydrogen, which would be taken in through scoops on the surface of the rotor, and exhausted through outlets some distance away, also on the rotor surface. In that way, the rotor could be quite uniformly and more effectively cooled throughout its length, and output greatly increased in relation to the physical dimensions of the generator.

An important problem was found in the extruded shapes. Design requirements had to be adjusted to the opportunities and practicalities of the extrusion process. Today these copper shapes, 20 feet long, drawn and finished to strict specifications as to dimensions and straightness, are making it possible to remove four times as much heat as conventional systems, and to double the generator output with no increase in size... For full information on extruded shapes, see the nearest Revere Sales Office.

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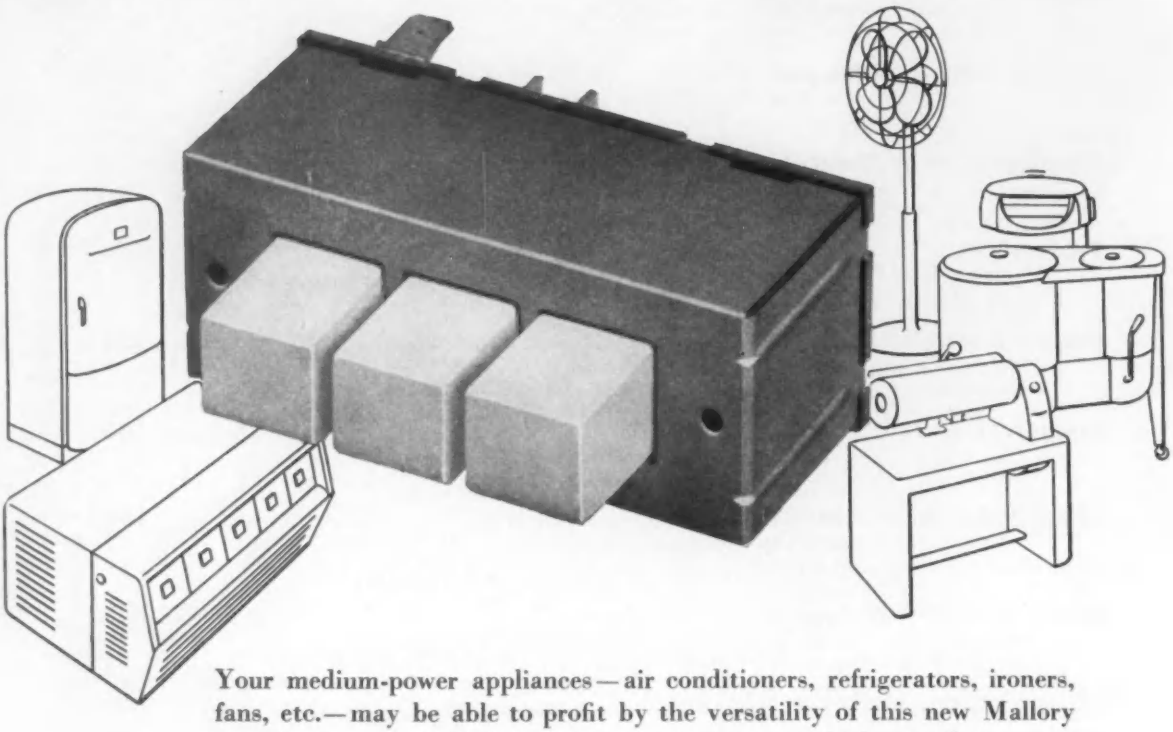
Can your product use this versatile new Mallory Push-Button Switch?



Your medium-power appliances—air conditioners, refrigerators, ironers, fans, etc.—may be able to profit by the versatility of this new Mallory push-button switch. Built into it are many features which contribute materially to performance of your product, and economy in your production:

VERSATILE SWITCHING. 24 different switching sequences are possible . . . affording a wide range of applications as either a 3-button or 2-button switch. Buttons can be supplied in varied colors and materials.

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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear. These items represent current research and design developments soon to influence product engineering.

METALLIC MATERIALS

....Stress-corrosion Cracking of aluminum base alloys can be prevented by keeping the tensile stress at a low level or by protecting metal against corrosion. Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif., states that a redesign of fitted parts to reduce assembly stresses and the use of coatings to prevent air-metal contacts are most effective. Residual compressive stresses—resulting from heat treatment—are also beneficial. Anodic coatings will also help to reduce aluminum failure.

AN ALUMINUM ALLOY . . . .

....especially developed for conducting electricity is a development of Alcoa, 1200 Alcoa Bldg., Pittsburgh 19, Pa. The alloy is claimed to have superior mechanical properties so often required in the manufacture of electrical equipment. Properties are important where high yield strength and low creep values are necessary. These properties are provided at only a slight sacrifice in electrical conductivity.

STRONTIUM 90 . . . .

....is being used to control the thickness of cold rolled steel to within 0.0005 of an in. Republic Steel Corp., 200 East 131st Street, Cleveland, Ohio, reports that the strontium activates control equipment that adjusts the 2,000,000 lb compressive force of the rollers.

STANDARD OF RESISTANCE . . . .

....for aluminum, corresponding to the resistivity of very high purity aluminum, has been agreed upon by seven countries. Basic value of resistance is 1/37 (0.027027) ohm mm sq per meter. Tentative approval for maximum resistivity of hard drawn aluminum wire is 0.028264 ohm mm sq per meter. Bus conductor value is 0.0290 ohm mm sq per meter.

NONMETALLIC MATERIALS

....Palm Oil Substitutes can be used as a lubricant in the cold rolling of steel on continuous mills. Armour Research Foundation, Technology Center, Chicago, Ill., reports that the most economical substitute is based on animal fat materials. These materials can result in a product that has no disadvantage and a number of operating advantages over palm oil.

SOLUTION CERAMICS . . . .

....are new and flexible ceramic coatings that can be applied to a wide variety of materials. Developed at Illinois Institute of Technology's Armour Research Foundation, Technology Center, Chicago 16, Ill., the coatings—which are liquid—can be sprayed at only a few hundred degrees F and will adhere to almost any solid surface.

A SILICONE RESIN . . . .

....developed for the paint industry—combines unusual heat resistance with an excellent balance of cure speed, flexibility and hardness. Silicone Products Dept., General Electric Co., Waterford, N. Y., reports that the resin may be used alone or modified with organic resins in formulating protective coatings. Special qualities are: initial gloss and gloss retention.

CERAMIC COATING . . . .

....of extremely low thermal neutron absorption coefficient is a development of the National Bureau of Standards, Washington 25, D. C. Coating can be used for high temperature protection of alloys in nuclear reactors. Also: coating is claimed to withstand thermal shock resistance tests from 2,000 F.

AMORPHOUS SILICA . . . .

....that has an extremely fine particle size, high purity and unusual degree of particle separation is a development of the Dow Corning Corp., Midland, Mich. Small amounts, it is claimed, added to polyester resins, results in properties that prevent drainage or loss of resin in many types of molding procedure. Uses are in fillers for polyester laminates where dielectric or high temperature properties are required.

HIGH STRENGTH FELT . . . .

....has been developed from Dacron polyester fiber by a new process investigated by E. I. du Pont de Nemours and Co., Wilmington 98, Del. Product is claimed to be capable of withstanding corrosive liquids and gases at high temperatures and has outstanding abrasive resistance. The process which involves heating the fibers to 300-400 F will retain 80 per cent of its strength after exposure to moist air at 350 F for 2 days. Wool felt, similarly tested, retains only 5 per cent of its strength.

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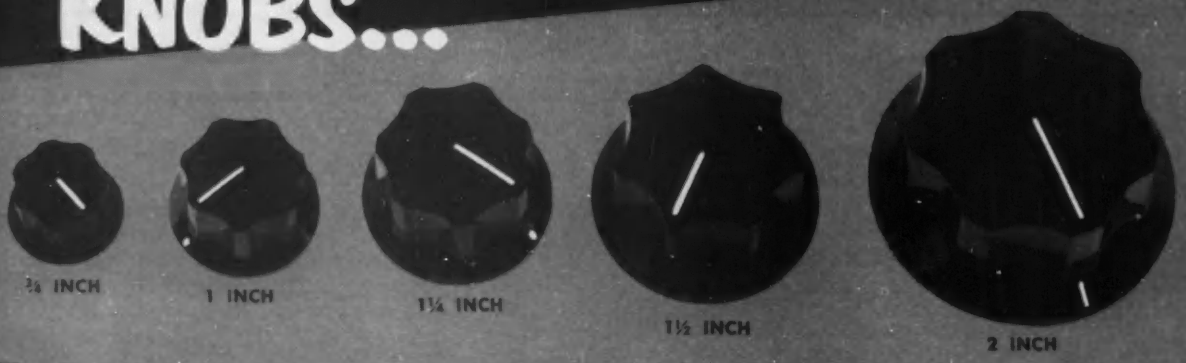
KNOBS...



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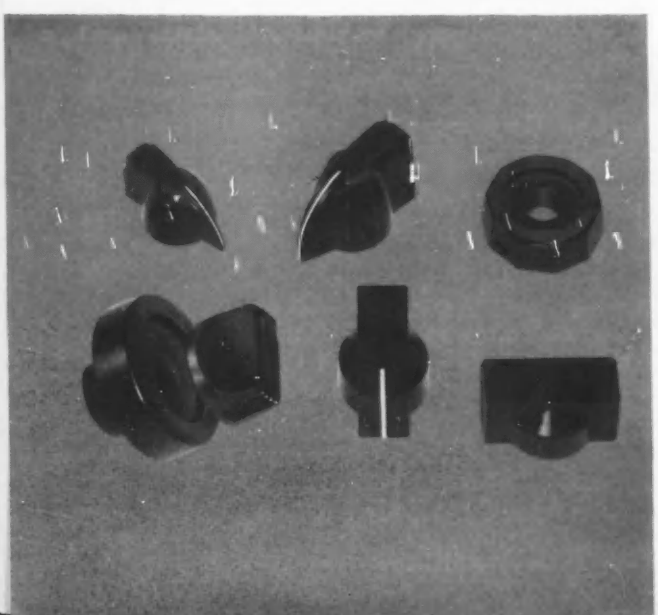

Don't overlook these popular Kurz-Kasch designs for bar knobs, pointer knobs and dual control vernier knobs.

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Highlights

PROCESSES

Automatic zinc plating has been developed for steel cartridge cases. To do this requires close control of concentrations of the various solutions as well as their purity, operating temperatures and maintenance of equipment. Riverbank Ordnance Plant, Riverbank, Calif., moves the work through the plating machine on an elevator conveyor that has a lift of 54 in. and a transfer of 36 in. per cycle. Cases are cathodic cleaned, rinsed, pickled and anodic cleaned automatically. A zinc chromate conversion film is applied by dipping or by electrolytic action.

A SIMPLIFIED PROCESS . . . .

. . . .for producing lithium has been discovered through a study of processing potassium from feldspar, quartz and trachyte. The research was carried on at Kochi University, Shikoku, Japan. Coal was mixed with the above insoluble minerals and produced 100 per cent potassium around a boundary temperature of 350-380 C. The process, it is claimed, was improved and applied to mica, actinolite and like minerals, eventually producing lithium by the process.

THE RECOVERY . . . .

. . . .of thorium and rare earths from monazite sand has been developed by the Battelle Memorial Institute, 505 King Ave, Columbus, Ohio. The presence of phosphates in the old process complicated the subsequent recovery of the metals. In the new method, it is claimed, phosphates are removed at an early stage by treatment, first with sodium hydroxide and then with hydrochloric acid. This simplifies purification of the thorium and rare earths.

DOUBLE MELTING TECHNIQUE . . . .

. . . .is reported to improve the homogeneity and purity of zirconium and titanium ingots. Murex Ltd., Rainham, Essex, England report recovery to be 95 per cent or better. Ingots 2 to 8 in. dia can be produced and 14 in. dia ingots appear possible. The cast slab is heated to 400-440 C and hot rolled in one direction until the temperature falls to 250-310 C at which time the strip is about 0.080-0.400 in. thick. After cooling the strip is cold rolled to 0.032 in. or less and finally annealed at 400 C to the soft condition.

CORE RODS . . . .

. . . .made wear resistant with tungsten carbide coatings are reported to outlast uncoated rods by 30 times. Linde Air Products Co., a division of Union Carbide and Carbon Co., 30 East 42nd St., New York, N. Y., reports that the coating is put on by the flame plating process. When rods start to wear undersize the thin tungsten carbide is removed and reapplied. Process can be repeated indefinitely. Test indicated that steel core rods produced 10,000 parts before wearing beyond the 0.0001 in. limit. Coated rods showed no wear after 300,000 parts.

EXHAUST SYSTEM LIFE . . . .

. . . .and other parts subjected to high temperatures may be increased from three to five times through the application of high temperature ceramic coatings. The Bettinger Corp., Gore Street, Waltham, Mass., reports the coating may be used on automotive, trucking, marine and heating equipment. The development has been made possible by coating the exhaust system—inside and outside—with a 0.001 to 0.002 in. thick coating. Ceramic coating it is claimed, resists corroding gases and operating temperatures up to 2,200 F.

COMPONENTS

Leather oil seal that provides low torque, cool operation, no measurable leakage and good life up to 200 F is a development of the National Motor Bearing Co., Inc., Broadway & National, Redwood City, Calif. Seal consists of a chrome retained leather sealing lip coated with a dry lubricant and an elastomer material. Center portion retains the natural porosity of leather, permitting the sealing member to absorb and store the lubricant.

ALUMINUM-TO-CERAMIC . . . .

. . . .joining can be used advantageously in the making of capacitors, high speed relay switches and other items requiring insulated hermetic seals. General Electric Company, 1 River Road, Schenectady, N. Y., reports that the ceramic section is coated with an alloy, and molten aluminum alloyed with the coated ceramic. Resulting dense aluminum layer around the ceramic is machined to the required dia, then brazed to the aluminum structure. Tests indicate that the seal is capable of withstanding high impact shock, vibration and corrosion.

TWO-COIL TRANSDUCER . . . .

. . . .designed for the precise measurements of deflection is a development of the Engineering Mechanics Section, The Franklin Institute, Benjamin Franklin Parkway at 20th St., Phladelphia 3, Pa. Sensitivity is the same as for a standard transducer. The unit is linear with a range of six in. Both coils have soft iron cores; one is the motion-sensitive element, the other the zero balancing element.

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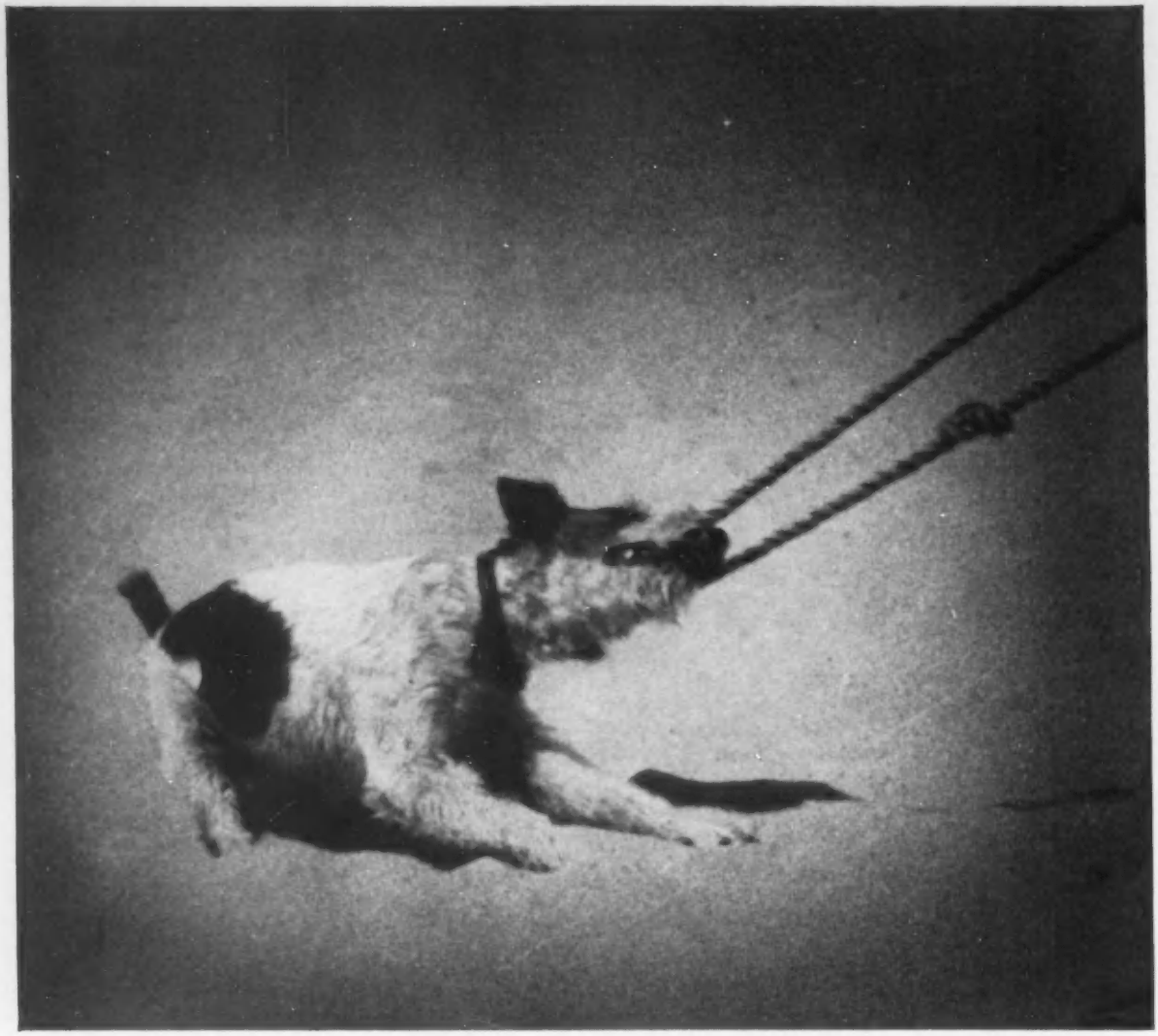

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corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

Highlights

SELENIUM RECTIFIERS . . . .

. . . .which show no indication of failure or decrease in output after more than 1000 hr at 150 C are being built experimentally by Bradley Laboratories, Inc., 170 Columbus Ave., New Haven 11, Conn. A program of high temperature selenium rectifier development is being carried out by the company in an effort to obtain longer life at high temperature.

TESTING

. . . .Rhodium is being tested to plate electronic circuits according to the International Nickel Co., 71 Wall St., New York, New York. It is being used for television, radar and for finishing etched copper circuits. These circuits are plated with rhodium to guard against corrosion and for protection against current leakage.

100 HOUR TEST . . . .

. . . .of a gas turbine operating at a speed of 30,000 rpm and a temperature of 1,850-1,900 F has been made by Kennametal Inc., 700 Lloyd Ave., Latrobe, Pa. The turbine—built by the company—incorporates an impeller, nozzle and inner housing of sintered titanium carbide. The material used is intended for application at temperature and stress conditions where other alloys and ceramics have not proved satisfactory.

MINIATURE SOURCES . . . .

. . . .of X-ray can be used for gaging thicknesses of plating and thin sheets, and to analyze the composition of materials by X-ray absorption. Armour Research Foundation, Technology Center, Chicago 16, Ill., reports that the units are small, stable and require no power—using isotopes with ½ life of several minutes to 20 years. The source may be excited by electron bombardment or nuclear fission.

SYNTHETIC RUBBER . . . .

. . . .designed for use in military aircraft is being produced experimentally by the Minnesota Mining and Manufacturing Co., 900 Fauquier Ave., St. Paul, Minn. Designated Poly-FBA, it can withstand temperatures to 400 F and is not affected by oils or gasoline. It can also be used with non-petroleum high-temperature lubricants used in jet engines.

IN COMING ISSUES

Impact of Basic Research on future product design, a special report in the 25th anniversary issue in January—staff evaluation of current research promising new industries and new products in the years ahead.

Engineering Department Economics—evaluating technical effort in terms of dollar return for dollar invested.

Flexible Shafts—factors influencing selection of core, casing and terminals for both power drive and remote control uses

Overload Relays—bimetal types combining overload and short-circuit protection for electric motor drives.

Foamed Isocyanates—properties and applications for foamed-in-place structural materials including both resilient and rigid types.

This Month's Cover

Measuring noise in an induction motor in General Electric's new anechoic room. An ever-increasing number of product users are becoming conscious of the hums, clicks, rumbles, whistles and roars present in working and living environments. Because the induction motor is so widespread in use, and in addition includes three major noise sources—magnetic, turbulent air and mechanical—the article starting on page 140, "Keeping Products Quiet," uses the induction motor as an example in discussing specific methods of reducing noise in products.

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Nitrous Oxide and Carbon Dioxide Mixtures
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Ethane
Ethylene (Industrial)
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Hydrogen
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Helium
Krypton
Neon
Nitrogen
Xenon

Manufacturers of Quality Pressure Regulators for more than a Quarter of a Century

PIONEER AND LEADER IN OIL FOG LUBRICATION FOR 26 YEARS

WRITE FOR COMPLETE DATA

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

Valves • Filters • Regulators • Lubricators • Hose Assemblies

LINK-BELT 25-hp P.I.V. Variable Speed Drive

cuts space requirements up to 50%

LINK-BELT gives you all the advantages of positive, stepless speed changing in high horsepowers, too

ONE of the great advantages of P.I.V.'s positive, all-metal drive is dramatically illustrated by the Size 6. Compared to other speed changers in this hp range, it saves *70 cu. ft. of space!*

In addition, infinitely stepless regulation means you can select the exact speed you want—from maximum to minimum. Unaffected by temperature and atmospheric conditions, all moving parts are totally enclosed and splash-lubricated.

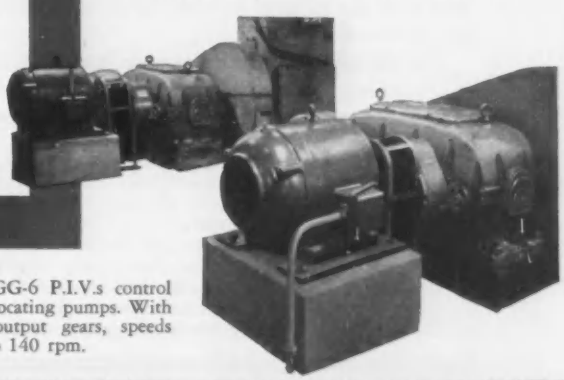
The Size 6 P.I.V. is built in three types: The basic drive . . . with input *or* output gears . . . with input *and* output gears. All are available in a wide range of ratios, 20 to 25 hp.

Get the facts on the Size 6 from your nearest Link-Belt office or distributor. You'll receive a copy of Folder 2374. And for information on the complete P.I.V. line, ask for Book 2274.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

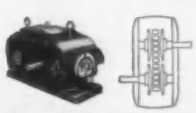
13,594

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

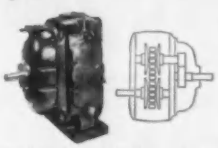


Two Link-Belt HGG-6 P.I.V.s control the speed of reciprocating pumps. With both input and output gears, speeds range from 46.5 to 140 rpm.

4 OF 16 P.I.V. TYPES
HORIZONTAL OR VERTICAL MOUNTINGS
½ TO 25 HP—
RATIOS TO 6:1

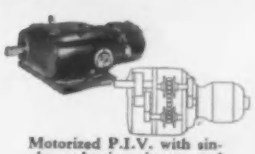


Basic, Positive, Infinitely Variable (P.I.V.) Speed Drive.



P.I.V. with single reduction input or output helical gears.

Motorized P.I.V. with single reduction input and output helical gears.



Motorized P.I.V. with single reduction input and double reduction output helical gears.

Shooting Completed – **NEW DIE CASTING FILM NOW READY!**

Get the Facts on ZINC Die Casting ECONOMIES

When you see the new motion picture "DIE CASTING—How Else Would You Make It?" (just released by the American Zinc Institute, Inc.) you will learn the basic reasons why ZINC Die Castings are so low in cost. You will find, for example, that their economy begins with the kind of machine on which they are produced.

The above scene from the new film shows a battery of high speed ZINC die casting machines. *Only* ZINC, among the principal die casting metals, can be cast in these machines. And this maximum production speed means minimum die casting costs to you.

But the 35-minute motion picture is not confined to the actual casting procedure. It also covers part design, die design, secondary operations, finishing and applications. It not only will help you to bring ZINC into proper focus among die casting metals but it establishes the relationship of die casting to other high speed production methods.

HOW TO SEE THE NEW FILM—

If you have access to projection equipment (the film is 16 mm. Kodachrome with sound) and can arrange to get a group together to see the picture, a print can be borrowed free-of-charge from the American Zinc Institute, Inc., 60 East 42nd Street, New York 17, New York. When writing, try to give several alternate dates for the showing and advise the size of the audience (you will also receive copies of a new 24-page booklet on die castings for those viewing the film).

The New Jersey Zinc Company
160 Front St., New York 38, N. Y.

ZINC
FOR DIE CASTING ALLOYS

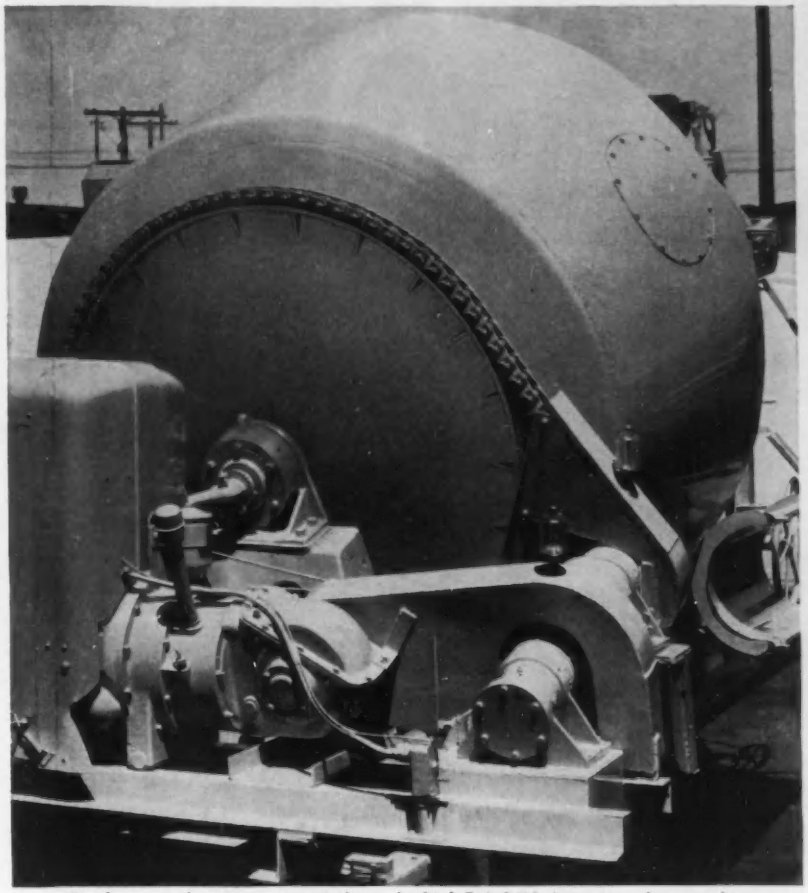
The Research was done, the Alloys were developed, and most Die Castings are based on

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

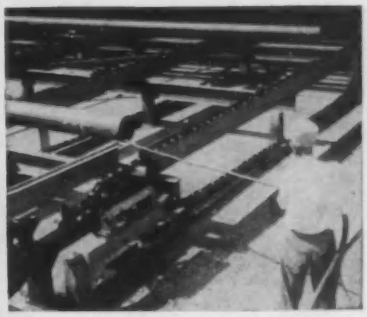
Leading design engineers choose this

Chain for severe conditions

...it's LINK-BELT LXS for drives and conveyors

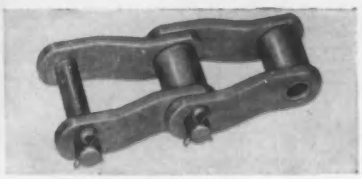


Truck-mounted concrete mixer is driven by Link-Belt LXS chain (guard removed).



Pipe mill cooling beds use LXS chain with attachments to move heavy pipe smoothly.

Advance-design shovel-crane gets its traveling and steering power through LXS chain.



Accurate sizing of full-round pins, bushings and pitch holes of LXS chain assures proper joint clearances and press fits.

No ONE chain serves every purpose--
get the RIGHT one from Link-Belt's *complete* line

FOR long life under severe drive or conveyor service, Link-Belt LXS chain is the choice of more and more leading designers. Here's a fabricated steel roller chain that *combines ruggedness with accuracy,* thanks to the manufacturing refinements that are a by-word at Link-Belt.

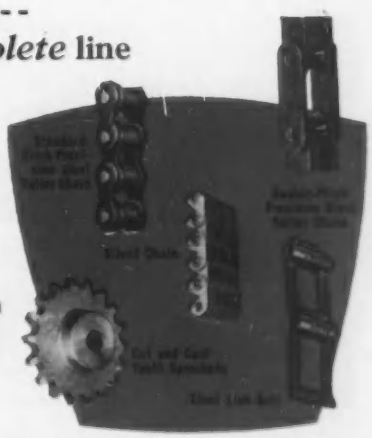
It's the same story for every drive and conveyor requirement — you'll find the chain that's *best* for the job in the complete Link-Belt line. No other single source can equal Link-Belt's broad range of roller and silent chain . . . of cast, combination, forged and fabricated types.

Your nearby Link-Belt office can give you all the facts. Why not call today for an expert, unbiased appraisal of your needs?

LINK-BELT

13,094

CHAINS & SPROCKETS



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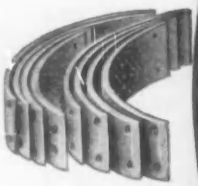
screened

FOR BETTER PERFORMANCE

in your product, too

No part of a precision performance product can ever be of dubious dependability. Automobile, aircraft, and other modern industries demand precise specification materials for all parts, however small. Industrial wire cloth goes into so many vital parts. It can't be just wire cloth. It should be Reynolds Wire Cloth. Precision-processed to the last detail—exactly to your specifications—to meet specifically the requirements of your individual parts, or products, and their uses. For details see *Sweet's Product Design File* ... or consult Reynolds Engineers.



Reynolds WIRE CLOTH for Industry

NS NATIONAL-STANDARD Company NILES, MICHIGAN

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., Box 200, DIXON, ILL.

Divisions of National-Standard Co.

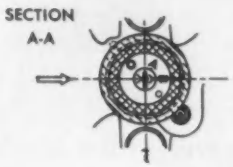
ATHENIA STEEL...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*.....Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes

NEW

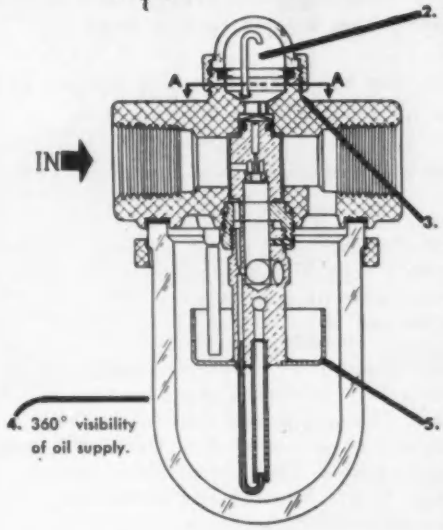
NORGREN MICRO-FOG LUBRICATORS FOR AIR TOOLS AND CYLINDERS

SIMPLIFY YOUR DESIGN PROBLEMS

distinctive Norgren features



1. VARIABLE VANE VENTURI View showing Index Marks "A" and "B" for Position of Rotatable Vane Type Venturi Plug.



2. 360° visibility of the oil feed

3. Oil feed controlled by auxiliary air circuit... gives an accurate and uniform rate of oil feed.

4. 360° visibility of oil supply.

5. Constant oil level... rate of oil feed not affected by oil supply.

6. Ability to produce a very fine oil fog and deliver it over long distances, through complex piping systems, and obtain equal distribution to multiple lubrication points.

FOR DETAILS WRITE FOR FORM 496

variable vane feature provides greater flexibility

- ***meet a broader range of operating conditions***
- ***each can handle jobs now done by several sizes of lubricators***

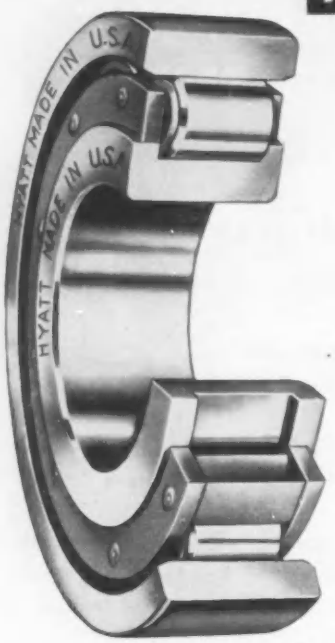
A simple adjustment inside the dome provides a wide range of air flow for varying conditions or different applications. Thus each lubricator meets a broader range of operating conditions and can handle jobs now done by several sizes of lubricators.

For example, at 80 psi the ⅜" size can be set for a low flow range of 5 to 9 cfm, a high range of 50 to 100 cfm, or any intermediate range desired.

The new line includes 20 models. Flow capacities: ¼", 5 to 40 cfm; ⅜" & ½", 5 to 100 cfm; ¾" & 1", 5 to 250 cfm. Sizes: transparent bowl, ½ pt.; tank type, 1¾ gal. and 4½ gal.

C. A. Norgren CO.
3428 So. Elati, Englewood, Colo.

ANOTHER VERSATILE HY-LOAD BEARING . . .

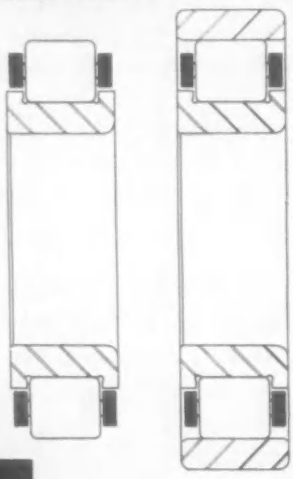


BU-Z

B indicates composite cage type—rollers spaced by conforming bars riveted to end rings

U indicates that the inner race has flanges at both ends to retain and align the rollers

Z indicates a separable straight cylindrical outer race



The Hyatt BU-Z Bearing is one of two basic Hy-Load types featuring a separable, interchangeable outer race, and is available in four series: 1200, 1300, 5200 and 5300.

Type BU-Z is designed for radial loads where the roller and inner race assembly must be kept with the shaft. The outer race may be omitted entirely, with rollers operating directly on the suitably hardened housing bore. This permits the use of larger-diameter shafts for greater rigidity—or smaller, more economical bearings.

Today thousands of products run smoother and last longer with less upkeep because of Hyatt Hy-Loads. If you're not already profiting from their use, contact your nearest Hyatt sales-engineer or write today for our Catalog No. 150. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT ◯ BARREL ◯ TAPER ◯

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, N. J.

Here's a New

"TRAFFIC COP"

for short high-speed runs

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

This new small Predetermining Ratchet Counter is set for any run up to 1,000 counts, pieces or other units by the three knurled setting knobs. Then it subtracts to zero, and at that point actuates a contact to light a light, ring a bell or stop the machine. Compact and easy to reset, this counter makes an attractive new selling feature when built into a machine as a standard integral part. And it's just one of scores of standard and special Veeder-Root Counters for every mechanical and electrical application in any field from atomics to automation. What would *you* like to count? Let Veeder-Root figure out how to do it. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

® **"The Name that Counts"**

"We're getting

twice the life from American "Quality Springs"

says NISSEN TRAMPOLINE CO. Cedar Rapids, Iowa

When George Nissen was a student in high school, he was fascinated with the antics of circus clowns on the safety nets. Using old inner tubes and a rope net, he built his first Trampoline.

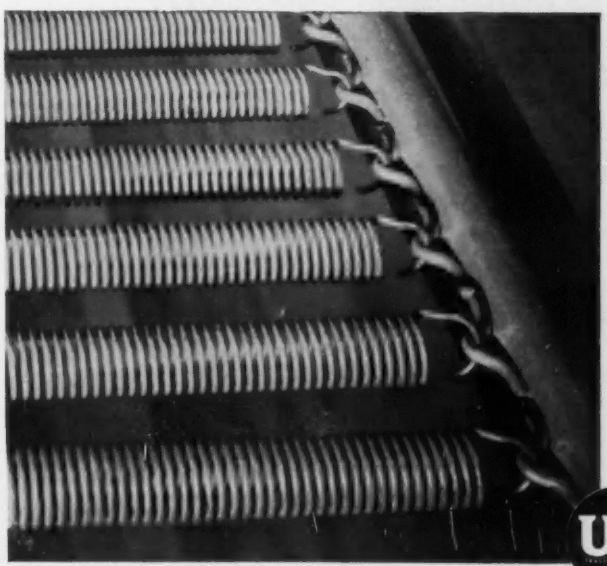
As the National Intercollegiate Tumbling Champion from 1935 to 1937, Mr. Nissen built the Trampoline into a breathtaking national sport—it was accepted in 1948 for competition by the National AAU.

Each Nissen Trampoline contains 120 American Quality Springs, 8" long, 1⅛" in diameter. The mat has to "give" three feet, and there is only 3½ inches clearance when the mat is bottomed. For this reason, the springs must have exactly the right deflection.

Concerning safety, Mr. Nissen says this: "We used to have spring breakage before using American Quality Springs. It was dangerous because the spring could rebound and seriously injure someone standing nearby. Since we switched to American Quality Springs, we've never had a customer complaint, and the springs last twice as long as before."

If springs are an important part of your product, American Steel & Wire may be able to design a *better* one for you. We'll give you any quantity, any size, any kind of steel or finish—at the lowest price you ever thought possible.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK



USS

USS American Quality Springs

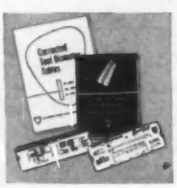
UNITED STATES STEEL

Look what you can do with Alcoa® Aluminum on your six-spindle Conomatics

Conomatics are the only multiple bar automatics built with short, "weaveproof" upright frame members secured between a large, heavy top bed and base. Such construction makes possible a strong bridged support for the tooling area and its "work and tool axis."

With such a strong and sturdy frame, you can really "horse" Alcoa Aluminum Bar Stock through your Conomatics. Finished parts are smooth, with dimensional tolerances held to consistently close limits. Piece costs are lower, since from a pound of aluminum you can get three times as many parts as from a pound of the heavier metals. What's more, aluminum parts won't rust or corrode and are exceptionally good conductors of electricity and heat.

Find out more about Alcoa Aluminum Screw Machine Stock—today. Contact your local Alcoa sales engineer or Alcoa distributor. Both are listed under "Aluminum" in the classified section of your telephone directory. Or write, ALUMINUM COMPANY OF AMERICA, 853-M Alcoa Building, Pittsburgh 19, Penna.



PRODUCTION AND DESIGN ENGINEERS will want two Alcoa booklets, *Alcoa Aluminum in Automatic Screw Machines* and *Corrected Tool Diameter Tables*. Also available at no extra cost are two precision computers —a Speed-Feed calculator, and an alloy property guide which shows at a glance the various properties of Alcoa Aluminum Screw Machine Stock.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

Look what *You* can do with Alcoa Aluminum on your Acme-Gridley automatics

Free-machining Alcoa® Aluminum Screw Stock and your Acme-Gridley automatics form smooth-working, fast-working teams. They can knock out aluminum parts easily, cheaply and fast. With aluminum, you can take full advantage of Acme-Gridleys' direct, close-coupled camming and wide-open tooling zone features to thread, tap, ream or deep drill. High speeds and feeds are possible with good surface finishes and close tolerances, uniformly maintained.

Piece costs are much lower since you can get three times as many parts from a pound of aluminum as from a pound of heavier metals. In addition, they are excellent conductors of electricity and heat. Aluminum parts take all finishes and are highly resistant to corrosion.

Find out for yourself what *you* can do with Alcoa Aluminum Screw Machine Stock. Contact your local Alcoa distributor or Alcoa sales engineer—your sources for Alcoa Aluminum and your short cut to experience in machining aluminum. Their offices are listed under "Aluminum" in the classified section of your telephone directory. Or, write ALUMINUM COMPANY OF AMERICA, 853-M Alcoa Bldg., Pittsburgh 19, Pa.

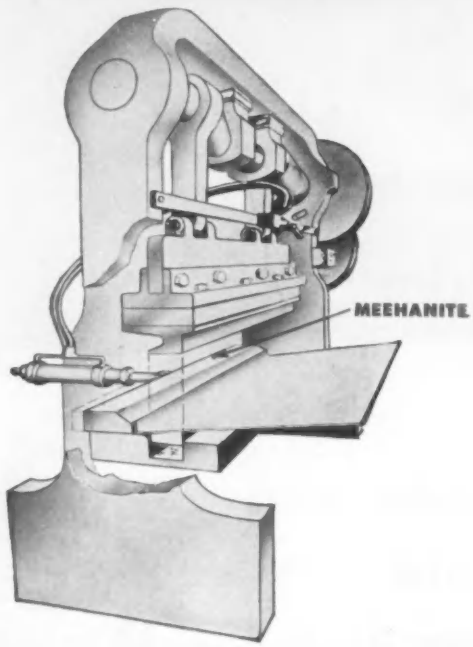
Alcoa offers *Alcoa Aluminum in Automatic Screw Machines*, a 95-page book containing information on tool design, setup and operating techniques. It is available to you at no cost just by writing on your company letterhead telling us your job function.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

The MEEHANITE® Casting Reporter

MEEHANITE BACK GAGE SAVES $100 PER DAY



In order to reduce production costs on a power brake, the manufacturer devised an automatic flanging die with a movable back gage which permitted the forming of 6 different bends with a single set-up. Materials handling savings amounted to $100 per day.

Originally the back gage, key to the operation, was made of hardened and ground steel but wore rapidly as a result of the horizontal thrust of the sharp edges of the steel sheet being worked.

The use of Meehanite metal for this gage solved the wear problem and three years after the installation the unit had gone through 9 million operations without removal for maintenance, repair, or straightening.

The manufacturer states **"The ability of Meehanite metal to meet the service requirements permitted the successful design and operation of the machine."**

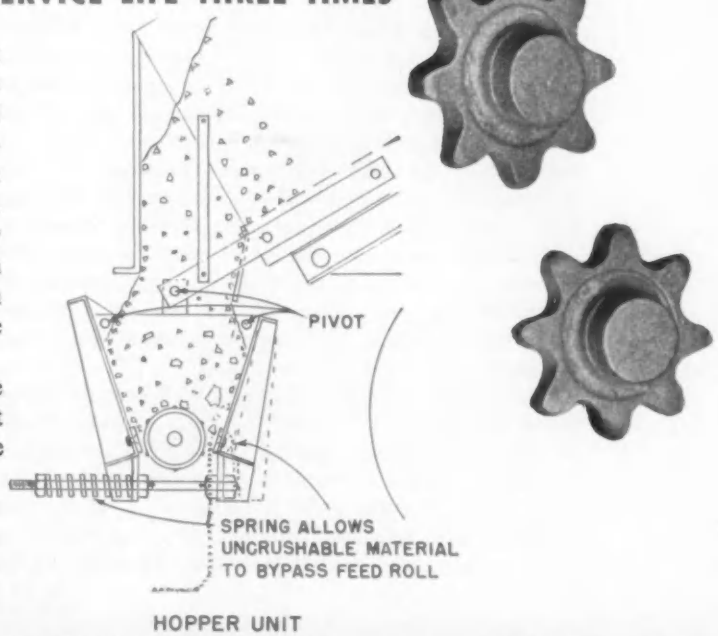
MEEHANITE SPROCKET INCREASES SERVICE LIFE THREE TIMES

In a sand and cinder spreader used for skid-proofing icy roads the operation of the material hopper is dependent upon a drive sprocket unit. The material being spread is fed between a feed roll and compression springs allow movement of the hopper sides in the event of hard, uncrushable pieces being passed.

The drive sprocket, when cast in high property bronze gave trouble through shearing at the clutch face when subjected to the high stresses created when hard and large lumps of material went through the hopper.

When produced as a Meehanite casting, the sprockets, after heat treatment, provided sufficient impact strength and abrasion resistance to eliminate breakage.

The manufacturer reports **"that substantial cost savings have resulted and the operating life of the Meehanite sprocket is generally three times that of the previous material."**



HOPPER UNIT

WHAT MEEHANITE CASTINGS HAVE DONE FOR THEM

HEAT TREATED MEEHANITE SCORING ROLLS REDUCE COST- IMPROVE WEARING QUALITIES

The ability to heat treat Meehanite castings and obtain increased hardness and greater wear resistance is revealed in the use of these castings for corrugated paper box scoring rolls.

The abrasive forces set up by corrugated paper are high and it is essential that the grooves and beads of the scores be machined to a high degree of accuracy. This, of course, is costly, and makes each days' service life important.

One large manufacturer of corrugated paper boxes declares: **"We use Meehanite rolls exclusively and find that the life of the units has been more than doubled since the specification of this material."**

ONLY A MEEHANITE FOUNDRY CAN MAKE MEEHANITE CASTINGS

American Brake Shoe Co. ..... Mahwah, New Jersey
The American Laundry Machinery Co. ..... Rochester, New York
Atlas Foundry Co. ..... Detroit, Michigan
Banner Iron Works ..... St. Louis, Missouri
Barnett Foundry & Machine Co. Irvington and Dover, New Jersey
E. W. Bliss Co. ..... Hastings, Mich. and Toledo, O.
Builders Iron Foundry ..... Providence, Rhode Island
Compton Foundry ..... Compton, Calif.
Continental Gin Co. ..... Birmingham, Alabama
The Cooper-Bessemer Corp. Mt. Vernon, Ohio & Grove City, Pa.
Crawford & Doherty Foundry Co. ..... Portland, Oregon
DeLaval Steam Turbine Co. ..... Trenton, New Jersey
M. H. Detrick Co. ..... Newark, N. J. and Peoria, Ill.
Empire Pattern & Foundry Co. ..... Tulsa, Oklahoma
Farrel-Birmingham Co., Inc. ..... Ansonia, Connecticut
Florence Pipe Foundry & Machine Co. ..... Florence, New Jersey
Fulton Foundry & Machine Co., Inc. ..... Cleveland, Ohio
General Foundry & Manufacturing Co. ..... Flint, Michigan
Georgia Iron Works Co. ..... Augusta, Ga.
Greenlee Foundry Co. ..... Chicago, Illinois
The Hamilton Foundry & Machine Co. ..... Hamilton, Ohio
Hardinge Company, Inc. ..... New York, New York
Hardinge Manufacturing Co. ..... York, Pennsylvania
Johnstone Foundries, Inc. ..... Grove City, Pennsylvania
Koehring Co. ..... Milwaukee, Wisconsin
Lincoln Foundry Corp. ..... Los Angeles, California
Palmyra Foundry Co., Inc. ..... Palmyra, New Jersey
The Henry Perkins Co. ..... Bridgewater, Massachusetts
Pohlman Foundry Co., Inc. ..... Buffalo, New York
Prescott Co. ..... Menominee, Michigan
Rosedale Foundry & Machine Co. ..... Pittsburgh, Pennsylvania
Ross-Meehan Foundries ..... Chattanooga, Tennessee
Shenango-Penn Mold Co. ..... Dover, Ohio
Sonith Industries, Inc. ..... Indianapolis, Ind.
Southern Illinois Foundry Co. ..... Carmi, Ill.
Standard Foundry Co. ..... Worcester, Massachusetts
The Stearns-Roger Manufacturing Co. ..... Denver, Colorado
Traylor Engineering & Mfg. Co. ..... Allentown, Pennsylvania
Valley Iron Works, Inc. ..... St. Paul, Minnesota
Vulcan Foundry Co. ..... Oakland, California
Warren Foundry & Pipe Corporation ..... Phillipsburg, New Jersey
Washington Iron Works ..... Seattle, Washington

Canada

Hartley Foundry Division — London Concrete Machinery Co., Ltd., Brantford, Ontario
E. Long Ltd., Orillia, Ontario **Otis Elevator Co., Ltd., Hamilton, Ontario**

Write for your copy of **"The Handbook of Meehanite Metals"**

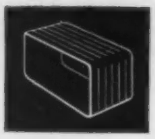
MEEHANITE METAL CORPORATION

714 North Ave., New Rochelle, N. Y.

This Advertisement Sponsored by Foundries listed above.

AUTOMOTIVE

The automotive company buying these door frames from Reynolds gets a combined structural and trim part ready for assembly and on model design changes saves large tooling costs on the door and components.



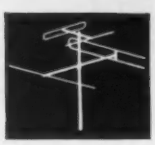
APPLIANCE

Reynolds now produces evaporators and over a dozen other parts for the refrigeration and air conditioning industry. They also produce washer and dryer tubs and many parts for electrical ranges.

America's leading industries buy aluminum parts fabricated by Reynolds

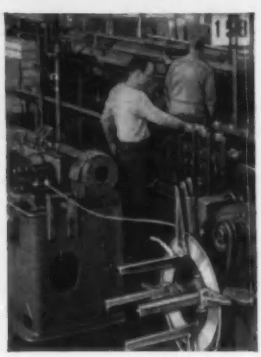
TRUCK AND TRAILER

Reynolds pioneered this field. Now, some of the leading companies in this industry have found that Reynolds presses and automatic welding equipment can produce trailer parts and prop wheels more economically and efficiently than anyone else.



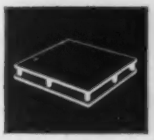
ANTENNA

Reynolds is now supplying a new and improved roll formed tubing to the leading producers of TV antennae—and it costs no more than regular tubing previously used.



REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING



MATERIALS HANDLING

The light weight and durability of aluminum, coupled with the fabricating experience of Reynolds, is making the use of aluminum pallets natural for companies who must ship their products on returnable pallets.

...and here's why

ENGINEERING SERVICE

The wide variety of industries served by Reynolds Aluminum Fabricating Service has made our engineering and sales force familiar with problems throughout the metal-working field. These trained salesmen and engineers plus many technical men are available to industry at all times. They will help you re-design your present parts to take advantage of aluminum, help design new parts of aluminum and show you how Reynolds can more efficiently and economically produce your parts for you.

FABRICATING EXPERIENCE

Reynolds Aluminum Fabricating Service has been producing aluminum parts for many different industries for many years. Through this experience has been gained a practically unparalleled knowledge of the fabricating of aluminum parts requiring blanking, embossing, stamping, drawing, riveting, forming, roll shaping, tube and shape bending, welding, brazing and finishing.

VAST DIVERSIFIED FACILITIES

There are over 200 pieces of major equipment in the 2 major parts producing plants of Reynolds. This includes presses from the very smallest up to presses capable of producing drawn parts 12' long. Also included are roll forming machines, some of the most modern aluminum welding equipment in the country and some of the most up-to-date automatic anodizing equipment.

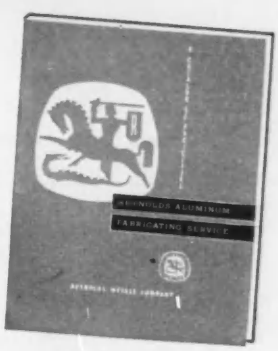
MONEY-SAVING ADVANTAGES

Reynolds parts customers save money many ways. Most important, they do not tie up their capital in raw material inventory and they do not have to buy "specialized" equipment which might be in use only part of the time. Parts from Reynolds Aluminum Fabricating Service are shipped ready to assemble into final products. This also saves on production losses, rejects and scrap handling and storage.

* * *

The industries covered on these pages are but a few examples of the many now being served by Reynolds Aluminum Fabricating Service. The leaders in these industries have found Reynolds experience and facilities to be valuable assets to their own excellent knowledge and facilities. For full details on how Reynolds can prove of assistance to you, call the Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.

Write for your copy of the new 24-page "Catalog of Facilities." Get full details on the tremendous production facilities of Reynolds Aluminum Fabricating Service.



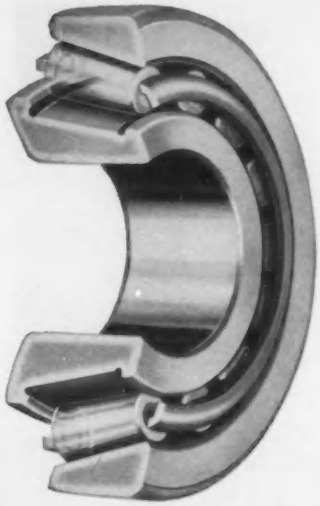
See "Mister Peepers", starring Wally Cox, Sundays on NBC-TV

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

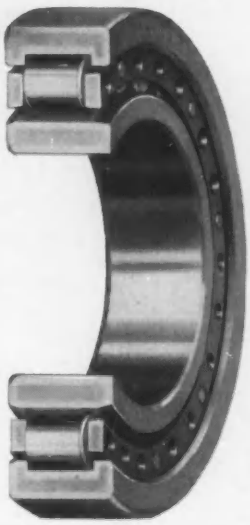
WHATEVER YOUR ROLLER BEARING APPLICATION

specify BOWER!



Earthmovers, jet turbine engines, rolling mill equipment, truck axles—you name it! Bower builds a complete line of tapered, straight and journal roller bearings including a size and type to fit *your* product. What's more, these dependable bearings have *proved* themselves in virtually every conceivable type of application. Their built-in quality, skillful engineering and advanced design features provide such important bearing advantages as reduced wear, longer life and lower maintenance requirements. Let a Bower engineer give you full details on the complete Bower line.

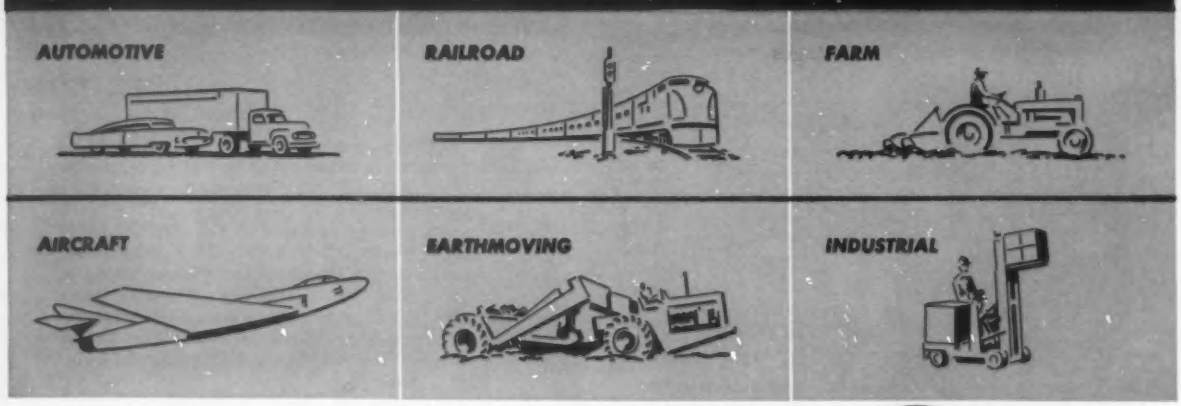
BOWER ROLLER BEARING COMPANY
DETROIT 14, MICHIGAN



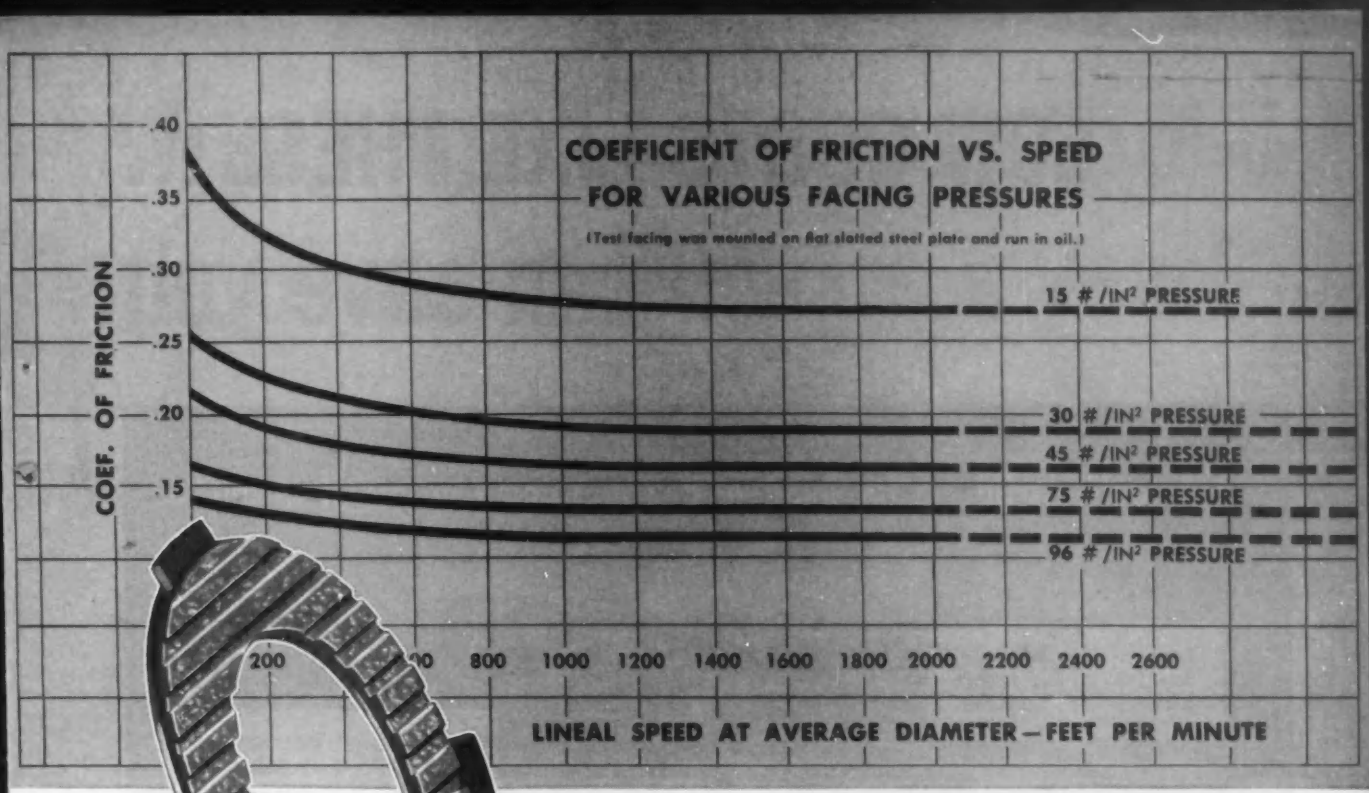
BOWER TAPERED ROLLER BEARINGS INCORPORATE ADVANCED SPHER-O-HONED DESIGN! Spherically generated roll heads and higher flange with larger, two-zone contact area reduce wear, improve roller alignment and virtually eliminate "end play." This helps hold adjustment and pre-load longer and better. Larger oil groove provides positive lubrication.

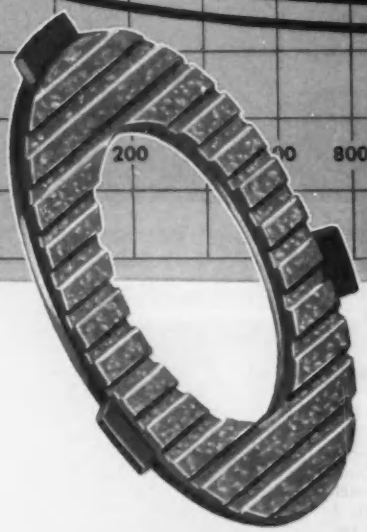
BOWER STRAIGHT ROLLER BEARINGS ARE BUILT TO CARRY MAXIMUM LOADS! Integral two-lip race increases rigidity—keeps rollers in proper alignment at all times. Steel cage allows free movement of rollers between races during normal operation. High-grade alloy-steel rollers and races are precision-ground for quieter, smoother operation.

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS
for every field of transportation and industry



BOWER
ROLLER BEARINGS
SPHER-O-HONED





Curves show how typical cork-compound facing delivers high coefficient of friction under varying engagement pressures. This shows usual pattern for cork facings mounted on slotted plates. Variations of this pattern can be obtained by using waved plates or unslotted plates.

In appliance clutches, cork facings offer economy and long, trouble-free service

If you're designing appliances that use clutches, you should investigate the unique advantages which cork-compound friction materials offer.

ECONOMY AND LONG SERVICE. Cork's unusually high coefficient of friction, even when immersed in oil, normally makes it possible to use fewer plates, to reduce the plate size, or to lower engagement pressure—and still maintain torque capacity. In such cases, substantial savings can be realized in material, metal, fabrication, and assembly.

Cork facings offer the further economy of long service. In a properly designed wet clutch, there is virtually no wear, and cork facings will last the life of an appliance and still be serviceable.

TROUBLE-FREE PERFORMANCE. Because they are resilient and non-abrasive, cork facings will not score or damage opposing metal plates. No metal particles are freed to damage gears and bearings. Thus, cork facings eliminate a common cause of clutch trouble.

A well-known appliance manufacturer discovered the value of these advantages when he used cork facings in place of metal friction plates. Cork's high torque capacity enabled him to use only three cork facings in place of eight metal friction facings—an important saving in material and labor. But equally important, the cork facings did not release abrasive particles into the oil. As a result, expensive service calls and clutch replacements were virtually eliminated.

Appliances are only one field where cork friction materials are used today. There are many other applications in such fields as automotive and industrial equipment and business machines. Tell us your problem, and we'll gladly help you choose the most efficient cork compound for your clutch. Write Armstrong Cork Co., Industrial Div., 7212 Irvin St., Lancaster, Penna.

Armstrong FRICTION MATERIALS

LOW COSTS LIKE THESE...
can save you

Actual cost figures for material and machining in lots of 10,000*

Brass . . . . . $.052 each
Steel . . . . . .068 each
Aluminum . . . .045 each

Brass . . . . . $.065 each
Steel . . . . . .047 each
Aluminum . . . .048 each

Brass . . . . . $.148 each
Steel . . . . . .160 each
Aluminum . . . .107 each

Brass . . . . . $.170 each
Steel . . . . . .190 each
Aluminum . . . .117 each

Brass . . . . . $.062 each
Steel . . . . . .050 each
Aluminum . . . .045 each

Brass . . . . . $.332
Steel 153
Aluminum 185

Material costs of above parts in lots of 10,000
Brass . . $.543 each Steel . . $.189 each Aluminum . . $.290 each

Production costs of above parts in lots of 10,000
Brass . . $.286 each Steel . . $.479 each Aluminum . . $.257 each

Material and Production costs of above parts in lots of 10,000
Brass . . $.829 each Steel . . $.668 each Aluminum . . $.547 each

Cost reduction by using aluminum
34.1% less than brass — 18.5% less than steel

*Figures given for brass and steel parts *do not* include the large plating costs that would have been necessary if these materials were used. Aluminum required no plating because of its natural attractive finish and resistance to rust and corrosion.

WITH KAISER ALUMINUM STOCK thousands of dollars a year!

Look at these cost comparison figures for the 6 screw machine parts in this camera tripod. It is manufactured by the R. J. Fisby Manufacturing Company of Chicago, a member of the National Screw Machine Products Association.

Frisby effected these savings because of the low material and machining cost of aluminum and because the natural attractive finish of aluminum required no expensive plating as with brass and steel. In addition, aluminum is so light in weight that substantial savings in postage were realized on this direct mail item.

Here's why *you* can cut costs and get better parts by specifying aluminum:

- Your screw machine parts supplier gets up to three times more feet of stock from a pound of lightweight aluminum than he gets from a pound of brass or steel. *Three times as many parts!*
- Your supplier makes other savings that can often be passed on to you. Aluminum may permit him to reduce machine time and extend tool life. It gives him a ready market for recovered scrap. And aluminum often eliminates the need for expensive plating—a major economy that greatly reduces the price of the finished part.
- Better parts can result with aluminum because it gives you a unique combination of advantages, including light weight combined with strength, attractive finish, high resistance to corrosion, excellent conductivity of heat and electricity, heat and light reflectivity.

More and more screw machine parts suppliers find aluminum EASY to machine.

Screw machine operators all over the country are working aluminum on any existing screw machine at both high and low speeds.

Only a few easy changes are required to work aluminum instead of brass. For example, different tool angles are necessary. On long runs, carbide-tipped tools should be used. Simple tool re-designs provide the rakes, clearances and chip-breakers that are best for aluminum.

And to help screw machine shops machine aluminum most effectively, Kaiser Aluminum engineers are available to recommend angles proved best by operators experienced in aluminum.

On your future screw machine parts bids, always ask for the price in aluminum. The savings will be big, and the quality will probably be better!

If you would like more information, contact the Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Kaiser Aluminum

setting the pace—in growth, quality and service

Westinghouse Ignitrons

get Positive Thermal Protection

with

KLIXON

Thermo Snap® CONTROLS

Westinghouse Ignitrons, used by leading manufacturers of electronic resistance welding controls make possible up to 400 perfect welds per minute. In addition, life expectancy is unusually high considering the tough, continuous high production operation.

Klixon 4391 hermetically sealed Thermo-Snap temperature controls help the Westinghouse Ignitrons deliver this outstanding performance. Donald E. Marshall, Power Tube Section Engineer of the electronic tube divisions, has this to say:

"THE KLIXON TYPE 4391 thermostat has proven to be the best choice for use with WL-5551/A and WL-5552/A IGNITRONS for thermal protection and increased water savings."

Designers and manufacturers seeking accuracy and efficiency in temperature control rely more and more on Klixon Thermo-Snap Controls.

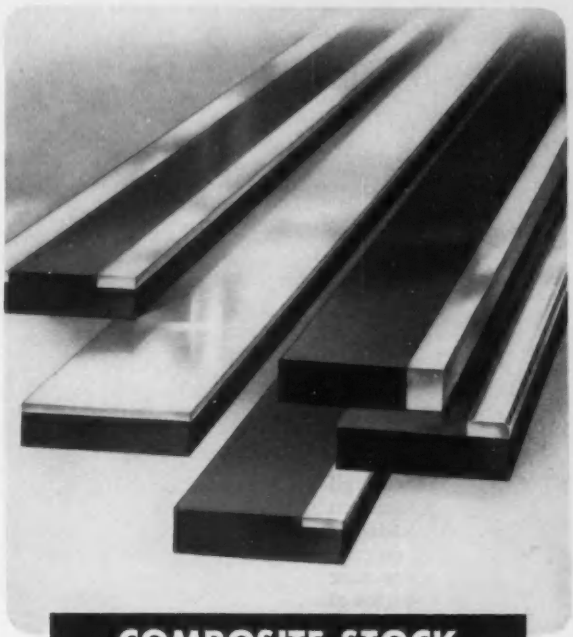
Klixon Thermo-Snap Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges. Write for complete information, today.

KLIXON

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
912 FOREST STREET, ATTLEBORO, MASS.

General Plate

COMPOSITE CONTACTS



COMPOSITE STOCK

FABRICATED ASSEMBLIES

Composite Contact Material
that meets your requirements
Composite Contact Assemblies
that cut your costs!

There are many advantages for using General Plate composite contact materials, processes and facilities. Among the more important are better performance, longer operating life and lower fabricating costs.

But that's not all — here at General Plate you have a single source that can supply your contact requirements be it composite raw stock, contacts or complete assemblies. General Plate stock and contacts are available in a wide range of alloys designed to meet your specific requirements.

General Plate Composite Contact Materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods.

By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

Write for complete information and Catalog PR700.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
112 FOREST STREET, ATTLEBORO, MASS.

Extra flexibility in unconventional corrugated tubing ... U.S. Multi-Flex

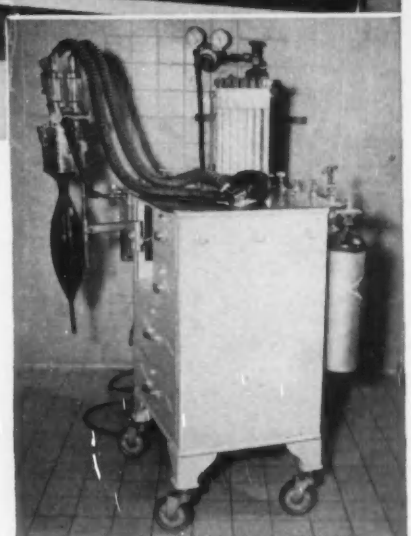
New demands — in industry and in medicine — call for corrugated tubing of extreme flexibility. Equipment designers find U. S. Rubber's unique Multi-Flex® process greatly simplifies their problems.

Multi-Flex means versatility in application. In the medical field, for instance, Multi-Flex corrugated tubes combine *extra flexibility* with *lightness* for anesthesia equipment, and chest respirators. They are resistant to crushing, are non-kinking. When made of conductive rubber, they prevent build-up of static charges.

Multi-Flex products have many small corrugations, yet are made without molds, specially tooled mandrels or inner supporting wires. They are available in any length in diameters from ¼" up. These tubes are made of all rubber, both natural and synthetic, or in combination with various fabrics.

Taking advantage of Multi-Flex Tubing's extreme extensibility, many manufacturers have adopted it for use as a hose on vacuum cleaners, rug shampoo equipment, industrial gas masks and many other products. Multi-Flex Excluder Boots, Air Ducts, Flexible Connectors and Bellows are in wide use throughout industry.

Any designer will do well to investigate the potentialities of this new, unique and economical process. For engineering advice and assistance, call on any of our 27 District Sales Offices, *or* write to address below for a copy of our Multi-Flex Catalog.



Note flexibility of Multi-Flex Tubing on chest respirator (top photo) and (lower photo) on anesthesia equipment.

"U.S." Research perfects it . . . "U.S." Production builds it . . . U.S. Industry depends on it.

UNITED STATES RUBBER COMPANY

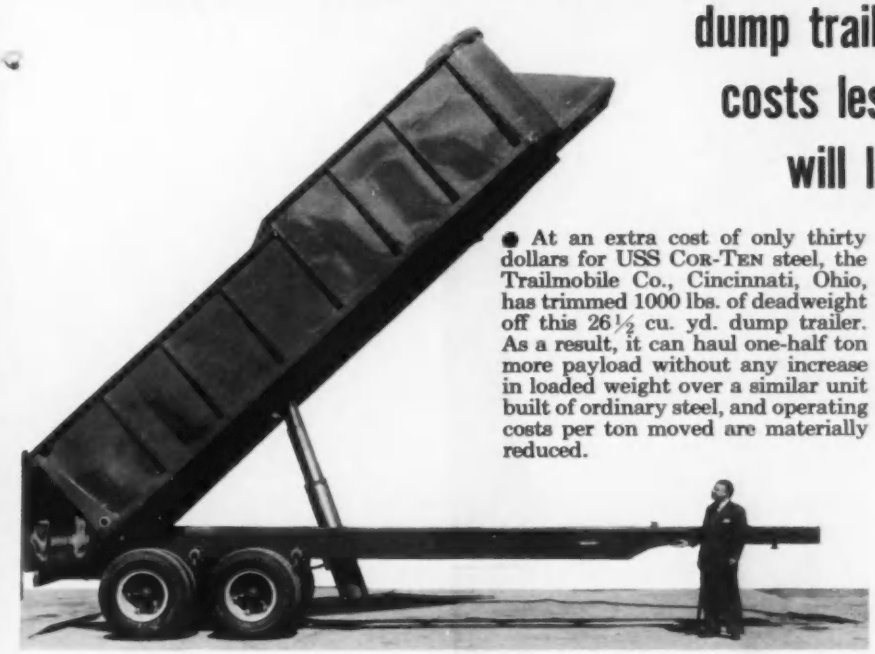
MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Pipe and Fittings • Grinding Wheels • Packings • Tapes Molded and Extruded Rubber and Plastic Products • Protective Linings and Coatings • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

New facts for your file on USS HIGH STRENGTH STEELS

Built 1000 lbs. lighter with USS COR-TEN steel

dump trailer hauls more, costs less to operate, will last longer



● At an extra cost of only thirty dollars for USS COR-TEN steel, the Trailmobile Co., Cincinnati, Ohio, has trimmed 1000 lbs. of deadweight off this 26½ cu. yd. dump trailer. As a result, it can haul one-half ton more payload without any increase in loaded weight over a similar unit built of ordinary steel, and operating costs per ton moved are materially reduced.

But USS COR-TEN steel does more than save weight and lower operating costs. Its high yield point of 50,000 psi—one and a half times that of carbon steel—gives the trailer body exceptional strength and toughness. Its much higher resistance to atmospheric corrosion, its superior resistance to abrasion, impact and wear greatly increase durability, keep the trailer on the job and help to prolong its life.

Since its introduction twenty years ago, USS COR-TEN steel has been used by 27 leading builders of trucks and trailers—names famous in the commercial car industry—to produce equipment that is lighter, more durable, able to do more work and cheaper to operate and maintain.

50% stronger and 20% lighter,

concrete forms of USS COR-TEN Steel last almost twice as long as carbon steel, materially reduce shipping costs

On many construction jobs, steel forms to hold concrete in place until it has hardened are now used instead of expensive wasteful forms built up of ordinary construction materials.

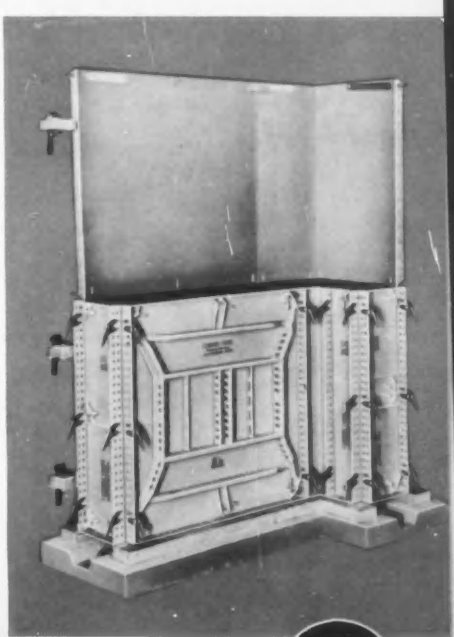
Such steel forms not only speed up work and save labor costs but, because they can be used over and over, save material as well.

A major producer of steel concrete forms is the Economy Forms Corporation, Des Moines, Iowa, which rents forms to contractors. This manufacturer reports that COR-TEN Steel used in their forms since 1948 has effected substantial savings because of its greater strength and higher corrosion resistance as compared to carbon steel.

For example, carbon steel forms, 30" x 30", can withstand a pressure of 1000 lbs. per sq. foot. They weigh 48 lbs. each and last about 6 years. In contrast, COR-TEN Steel forms of the same size, can withstand a pressure of 1,500 lbs. per sq. foot, but they weigh only 38 lbs. each and have a probable life of 8 years. The use of COR-TEN sheets for these forms has reduced the maintenance cost approximately 40%.

Concrete forms are shipped an average of ten times each year and here COR-TEN Steel forms pay further dividends because they weigh less.

Economy Forms Corporation estimates their freight savings to be 10¢ to 12¢ per sq. ft. per year, which runs into a pretty penny when you consider that they have 1,200,000 sq. ft. of forms in use.



UNITED STATES STEEL COMPANY, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

UNITED STATES STEEL

New facts for your file on

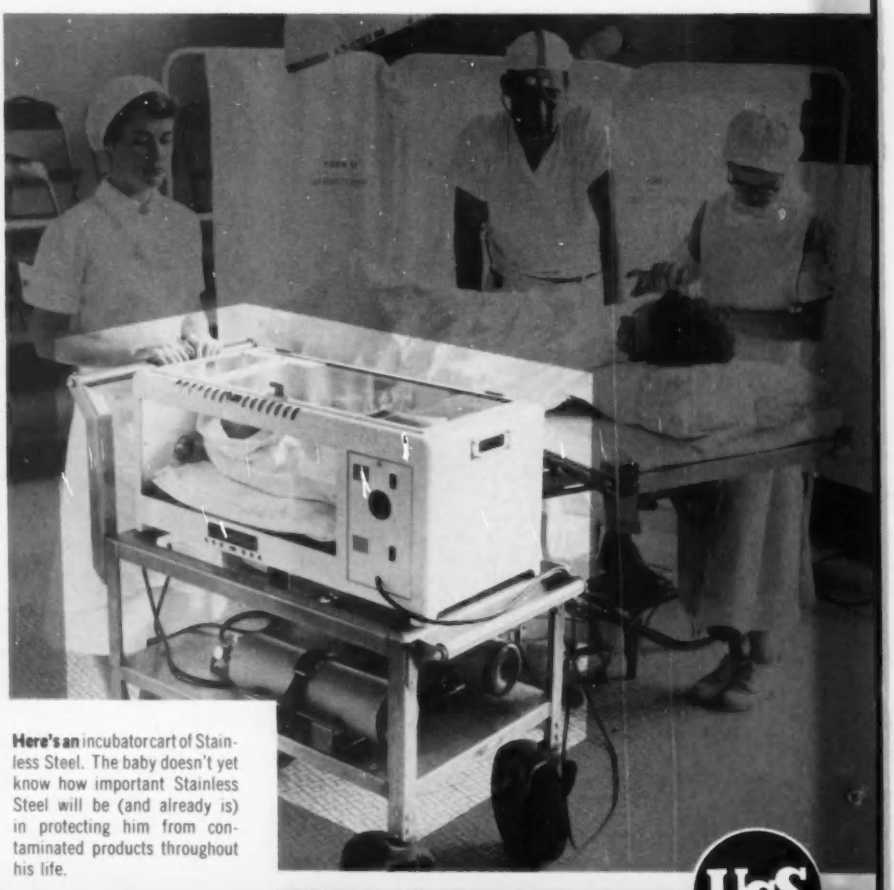
Hospitals depend upon Stainless Steel in kitchens and operating rooms...

This open-tray truck is also of Stainless Steel. So it will last longer and will be easy to keep clean and good-looking.

Another shining example of Stainless Steel beauty, this battery of food conveyor trucks will see many years of trouble-free service in the Cook County Hospital kitchen.

it's so easy to keep clean and sanitary

Stainless Steel equipment is vital to the operation of all modern hospitals. The Cook County Hospital in Chicago uses Stainless Steel extensively wherever equipment must be kept clean and sanitary. Only Stainless Steel is so dependably safe and so long lasting. It effectively resists rust and corrosion, is easy to keep clean and shining. All the Stainless products shown here are supplied by Colson Corporation of Elyria, Ohio.



Here's an incubator cart of Stainless Steel. The baby doesn't yet know how important Stainless Steel will be (and already is) in protecting him from contaminated products throughout his life.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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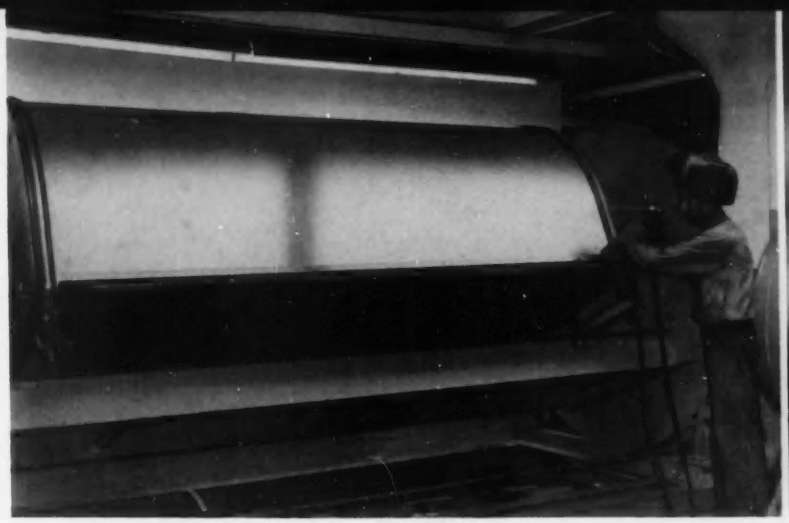
UNITED STATES STEEL

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS



Here's the jig that holds the body sheets while the end sheets are arc welded on.

Frank Ramacier, shop foreman, inspects the finished pasteurizer.

Stainless Steel requires good mechanics, a little care, and good equipment for fabricating

Frank Ramacier, Metal Shop Foreman at the Farwell Metal Fabricating Division of Farwell, Ozman and Kirk Co., St. Paul, has been handling Stainless Steel and other metals for over 20 years. Says he, "If a fellow's a good metal worker, it doesn't take much to teach him how to handle Stainless." He recommends, of course, care in handling and good equipment in good condition.

As an example, let's see exactly how Farwell goes about fabricating a big 500-gallon milk pasteurizer . . .

302 Stainless Steel is used; 18 gage end sheets and 20 gage body sheets.

SHEARING. Paper protection is applied to protect the finish prior to shearing the 49½" x 106" sheets to 49" x 105". A ⅜" capacity shear with blades kept very sharp is used to assure greatest accuracy.

ARC WELDING. Two body sheets are butt welded together to make one body sheet.

NOTCHING. Heavy-duty (60-ton) press is used for top accuracy; notches sheet corners.

FLANGING. Five passes on a 16 gage capacity flanger secure 1" flange on end sheets.

BRAKING. ⅜" capacity brake press is used—again a heavy machine is used to guarantee greater accuracy. Top edge of the end sheets and top edge of the body sheet are flanged to 90°.

ARC WELDING. (second) Welding of the end sheets to body sheet is done on a special jig (see cut) that makes the welding easier and faster. The body sheet is shaped in this jig and is held until the end sheets are welded to it. Top corners are welded together. An outlet is arc welded.

GRINDING. Smoothes and polishes the welds.

That's it and another non-contaminating, corrosion-resistant Stainless Steel pasteurizer is ready to go to work.

Take advantage of Stainless Steel in your designs and in your selling

Here are just a few examples of how Stainless Steel has been used to improve design, add sales appeal, give better end use results. The wide range of valuable properties available in Stainless Steel makes it the ideal material for many, many jobs.

Put Stainless to work for you. It will pay its own way and give you good return on your investment — especially if it is perfected, service-tested USS Stainless Steel.

USS Stainless Steel offers you the widest possible freedom in selecting the grade, shape and finish to fit your design and fabricating procedure best. And the services of our metallurgical engineers are always at your disposal to help you cut costs and get the best results from USS Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

Sealing trailers at the seams

When you consider the amount of weathering to which a house trailer is exposed in the course of its service, you can appreciate the importance of effective, all-around sealing.

Finding a seal to keep out dust, weather and noise used to present a real problem. But it doesn't any longer—thanks to 3M's new ribbon-like sealer, EC-1202. Made of synthetic rubber, EC-1202 is extremely flexible and easy to handle. And it's reinforced with sturdy fabric so that it holds its dimensions and is exceptionally easy to apply.

On trailers, like the one pictured above, EC-1202 is used to seal metal corners and edges. Next, an extruded aluminum corner is bolted over it for extra protection, to provide a complete seal against weathering of all sorts.

See what adhesives can do for you . . . You can use EC-1202 wherever metal corners, edges, or faying surfaces need sealing. Your 3M sales engineer will give you all the facts on this and other 3M adhesives developed for industry. Call him, or write today for free informative booklet—to 3M, Dept. 412, 417 Piquette Ave., Detroit 2, Mich.

see our catalog in PRODUCT DESIGN FILE or write for copy

ADHESIVES AND COATINGS DIVISION **MINNESOTA MINING AND MANUFACTURING COMPANY**

417 PIQUETTE AVE., DETROIT 2, MICH. • GENERAL SALES OFFICES: ST. PAUL 6, MINN. • EXPORT: 122 E. 42 ST., N. Y. 17, N. Y. • CANADA: LONDON, ONT.

MAKERS OF **"SCOTCH"** BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • **"SCOTCH"** BRAND SOUND-RECORDING TAPE • **"SCOTCHLITE"** BRAND REFLECTIVE SHEETINGS • **"3M"** ABRASIVE PAPER AND CLOTH • **"3M"** ADHESIVES AND COATINGS • **"3M"** ROOFING GRANULES • **"3M"** CHEMICALS

it may help you!

Titanium is a metal the world has known for a long time—and now you can put its unusual combination of valuable properties to work for you in the form of Carpenter Titanium Tubing.

It's light. It's strong. It has a remarkable endurance limit. Weighing about 56% as much as high alloy steel, titanium has a tensile strength that compares favorably with many steels. It possesses an endurance ratio well above both steel and non-ferrous metals.

Carpenter Titanium Tubing is highly resistant to most corrosives, salt water and salt atmospheres. Its extreme resistance to erosion and cavitation is unique among metals. Yet, with all this, Carpenter Titanium Tubing is ductile, may be successfully machined.

With all these desirable characteristics—in combination—it may be that Carpenter Titanium Tubing can help you solve a number of design and production problems.

If you would like more information about Carpenter Titanium Tubing, and its place in your product or plant, write today to:

MEMBER

The Carpenter Steel Company,
Alloy Tube Division, Union, N.J.

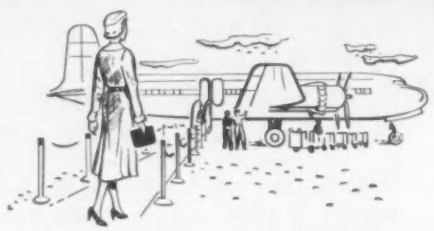
Export Dept.: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Carpenter

Stainless Tubing & Pipe

Here's a steam iron, travel-light, because of its DIE CAST sole plate!

CASE HISTORIES FROM MT. VERNON FILES



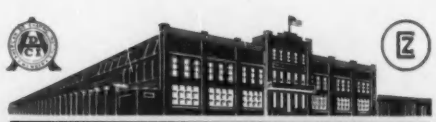
Think of it! An iron that presses efficiently both steam and dry, with 21 sq. in. of ironing surface — yet it weighs only 28 ounces, and folds into small space for traveling. That's the new "Stewardess," made by Landers, Frary & Clark, New Britain, Conn.

One basic reason this traveling iron is so sturdy yet so light is that the sole plate is of die-cast aluminum, made to the designer's exact specifications by Mount Vernon. The die-cast sole plate, containing a groove to hold the heating element, makes assembly quick, simple, economical.

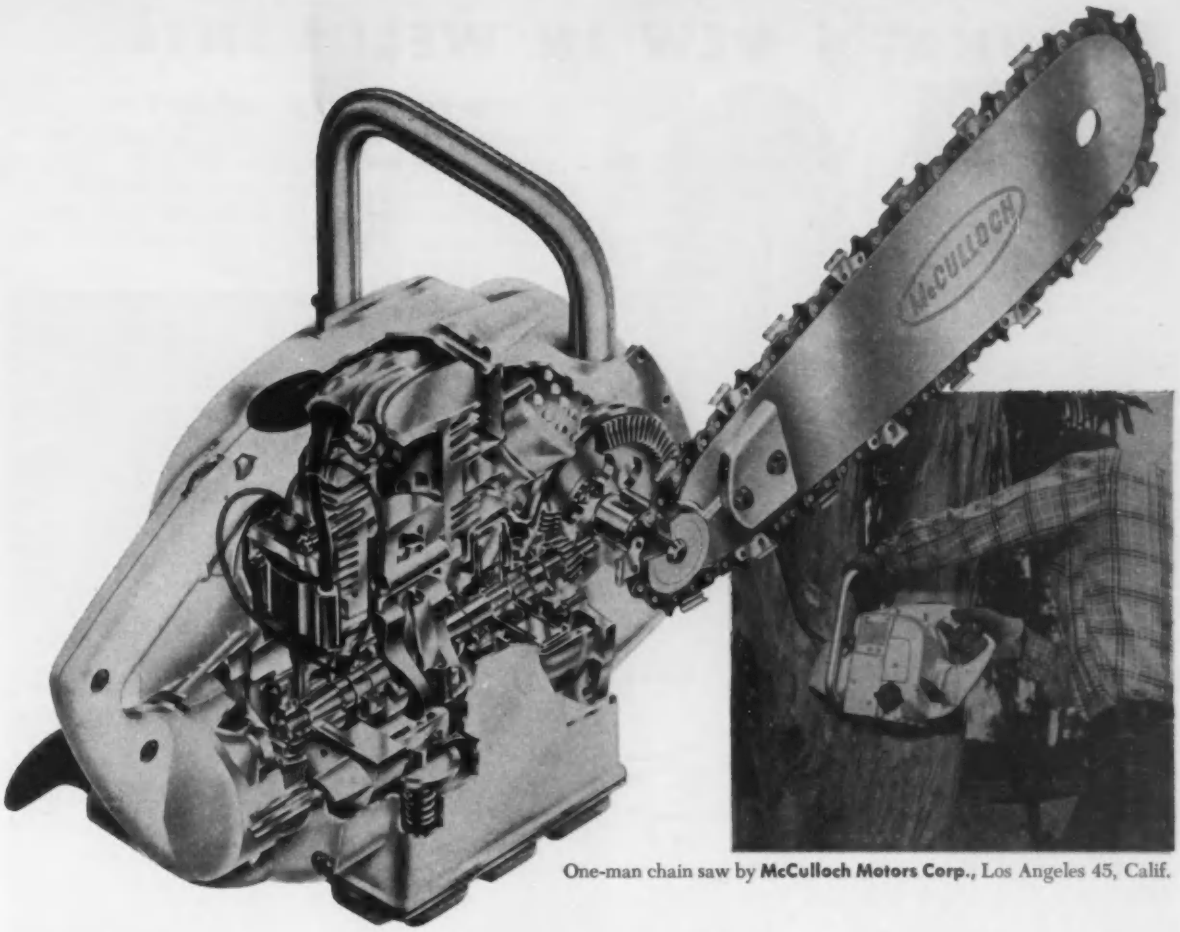
Today as never before, die casting is helping manufacturers in widely separated fields to production economies and sturdy, reliable performance. For die-cast parts combine strength with light weight — and even with intricate designs die casting is done to such close tolerances you need little or no machining.

Mount Vernon can help **you** make the most of these die casting advantages by our complete Four-fold Service: **(a)** ***consultation*** — to help with design and production problems; **(b)** ***die making*** — on modern tool and die equipment handled by skilled personnel; **(c)** ***castings*** — guaranteed "on grade" at all times; **(d)** ***machining facilities*** — for handling machining operations your castings may require.

A switch to die casting may profit you tremendously. Why not consult with us?

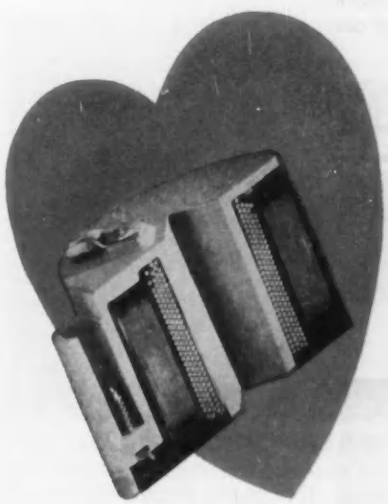


MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT



One-man chain saw by **McCulloch Motors Corp.**, Los Angeles 45, Calif.

HARD PLASTIC HEART MEANS AN ALL-WEATHER START



Cross-section of coil shows BAKELITE Epoxy Resins forming dark area. Note how they have completely filled crevices between the finest wires.

Wet weather, cold weather, high altitudes or low, the motor in this tough little 20-pound chain saw is sure to start. Safely embedded in a solid block of BAKELITE Epoxy Resin, its magneto and coil stay in permanent working order.

If your electrical applications have to work under similarly rugged conditions, you'll find that potting and encapsulating with BAKELITE Epoxy Resins offer an ideal solution. The liquid resin, mixed with its liquid hardener, is simply poured into place. It fills the tiniest crevices, completely protecting the coil from moisture—no electrical shorts result.

In a few hours at room temperature, without applied heat, the mixture changes to a permanently hard solid. There is practically no shrinkage. The smallest components are set firmly and immovably.

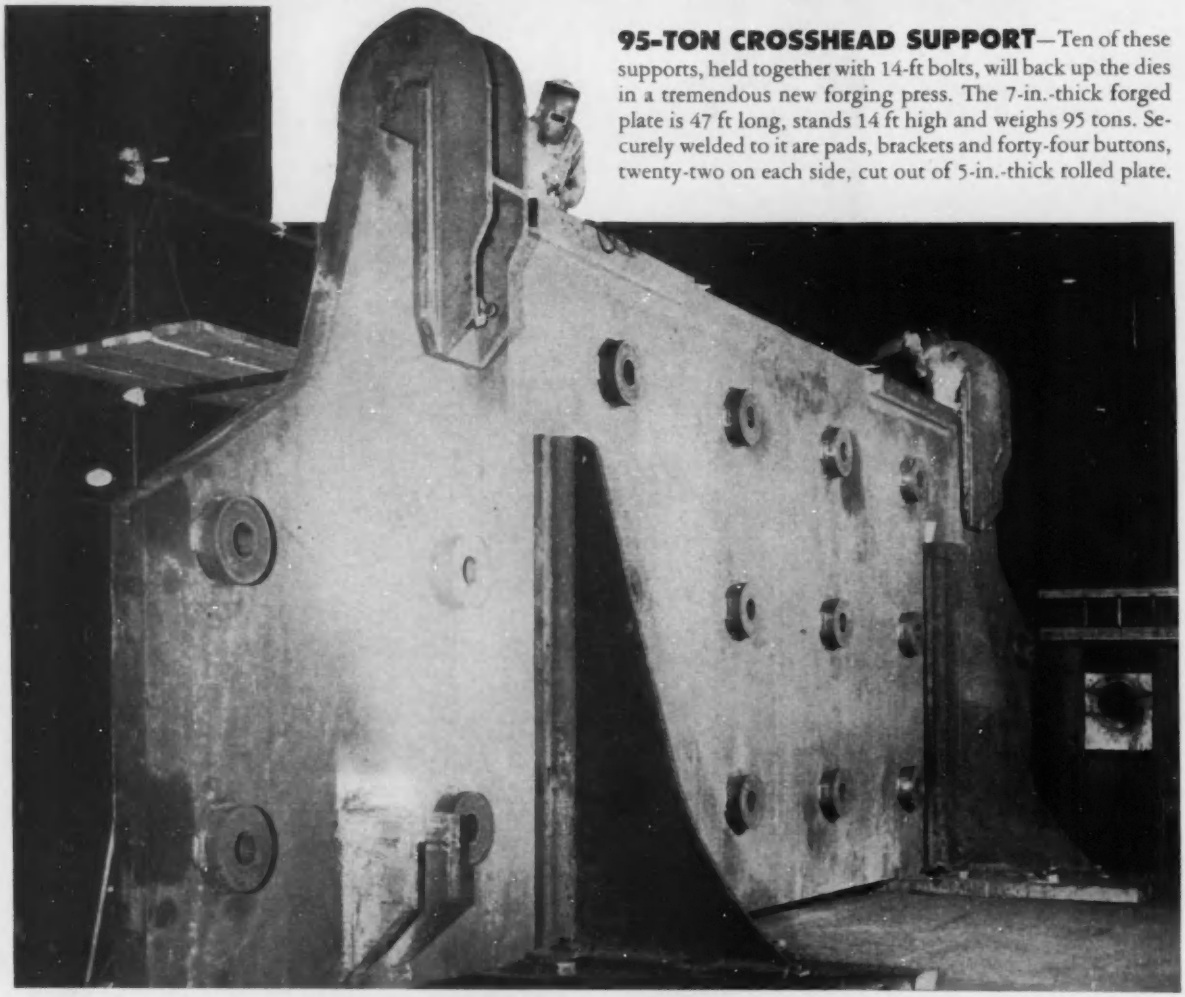
BAKELITE Epoxy Resins are resistant to moisture, oils and greases, chemicals, most acids and strong alkalies. Their dielectric strength and adhesive properties are excellent. They are relatively light in weight.

Perhaps they can help build extra service features into your product. For detailed information on BAKELITE Epoxy Resins, and a list of suppliers, write Dept. XR-10.

BAKELITE
TRADE-MARK
EPOXY RESINS

TRADE MARK
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.

WHAT'S NEW IN WELDMENTS



95-TON CROSSHEAD SUPPORT—Ten of these supports, held together with 14-ft bolts, will back up the dies in a tremendous new forging press. The 7-in.-thick forged plate is 47 ft long, stands 14 ft high and weighs 95 tons. Securely welded to it are pads, brackets and forty-four buttons, twenty-two on each side, cut out of 5-in.-thick rolled plate.

ELECTRONICS HELP IN TRICKY TRACING
Up-to-date burning equipment is at your service in the Bethlehem Weldment Shop. This electronic tracer speeds jobs that require great precision.

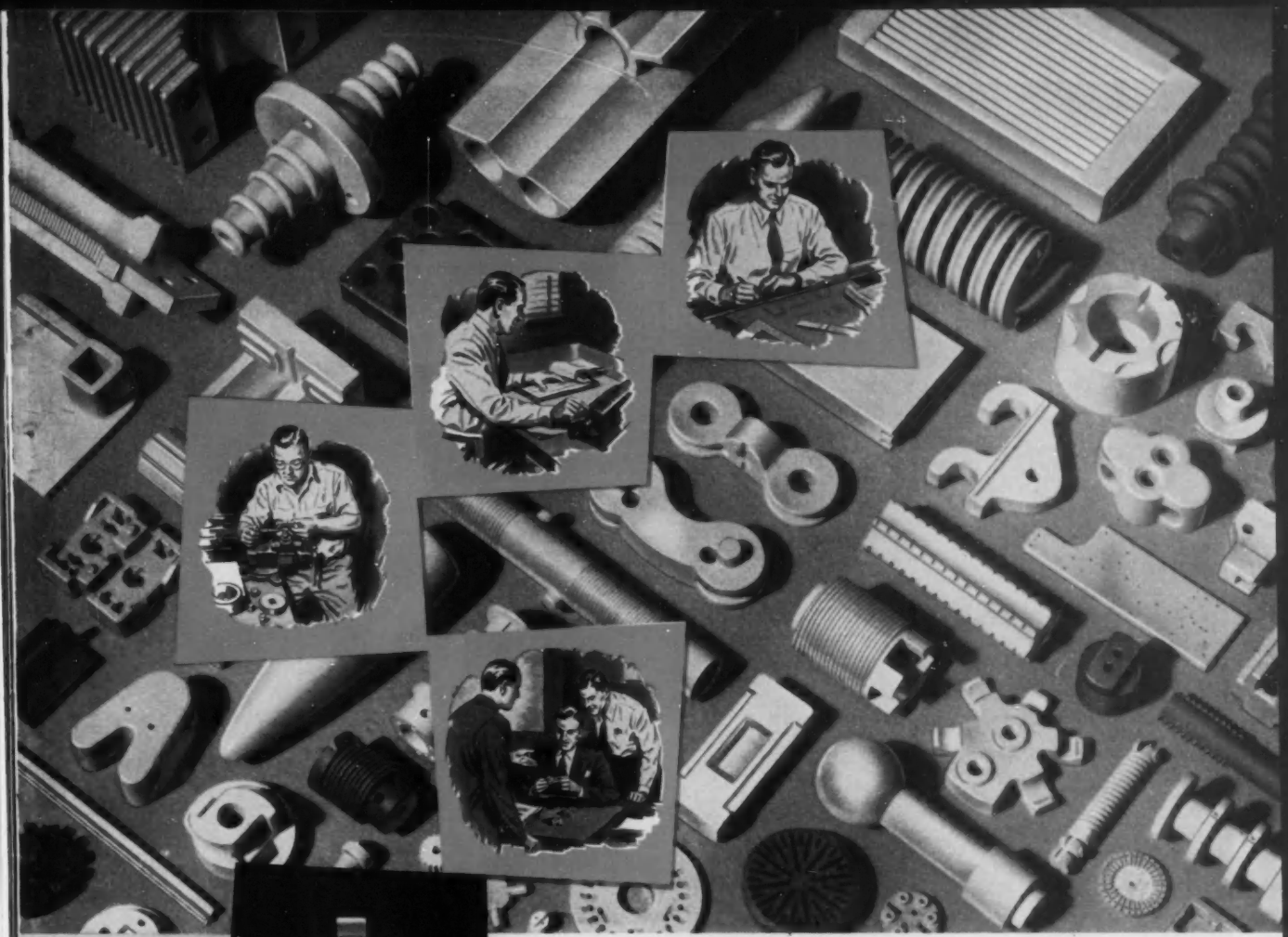
WE CAN CUT YOUR "FINGERS"—The equipment shown at the left was used in making this expansion dam for a highway bridge. The tapering fingers were burned down the 44-ft length of a 2-in.-thick rolled steel plate.

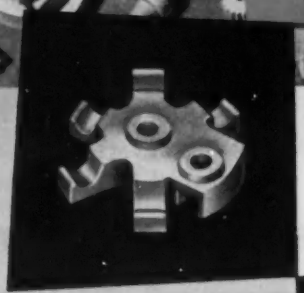
BETHLEHEM STEEL

For further information about Bethlehem Weldments, call on the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation





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(another AlSiMag Extra)

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Our Sample Order Department can quickly make up pieces to any new design that looks promising and let you test them thoroughly. When the final design has been decided upon, parts can be produced to specification in volume to match your requirements.

A blueprint or sample of your present part with outline of operating requirements will bring prompt action . . . which may save you lots of money.

Careful study of designs by our engineering staff (with more than 50 years of specialized experience) often results in recommendations which mean — **Savings** in manufacturing costs, **Savings** in speed and ease of assembly, **Savings** through improved performance, **Savings** from combining two or more parts for still greater economy.

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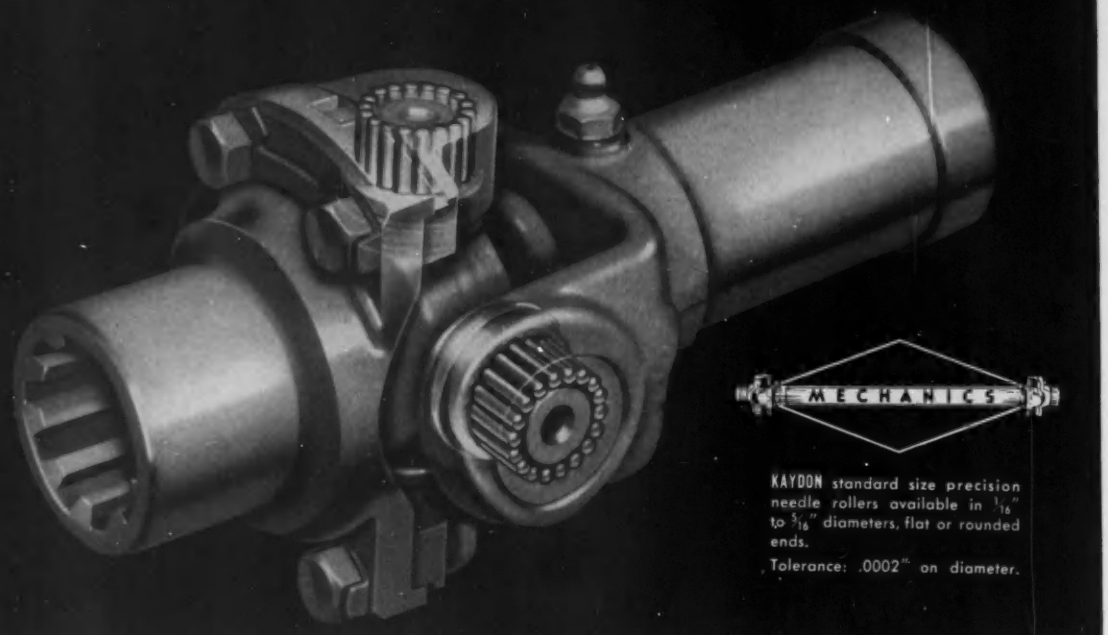
Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER

Engineered for 50,000,000 revolutions without added lubrication



KAYDON standard size precision needle rollers available in 1/16" to 5/16" diameters, flat or rounded ends.

Tolerance: .0002" on diameter.

KAYDON high-precision needle rollers used in MECHANICS' universal joints

KAYDON high-capacity, precision needle rollers are an integral part of automotive and truck universal joints built by Mechanics Universal Joint Division of Borg-Warner Corp.

KAYDON's low-cost needle rollers perform economically and efficiently at low or high speeds — continuous or intermittent operation. What's more, they're performance-proved for 50,000,000 revolutions or 20,000 miles without additional lubrication.

If, like Mechanics, you manufacture large or small universal joints, requiring needle rollers or any type of ball or roller bearing for applications in aviation, industrial, mining, agricultural and other industries — it will pay you to contact KAYDON of Muskegon.

Write for Catalog!

For complete data on capacity, design, separators, standard and custom designed KAYDON *Reali-Slim* bearings, write for this 24-page catalog, No. 24.

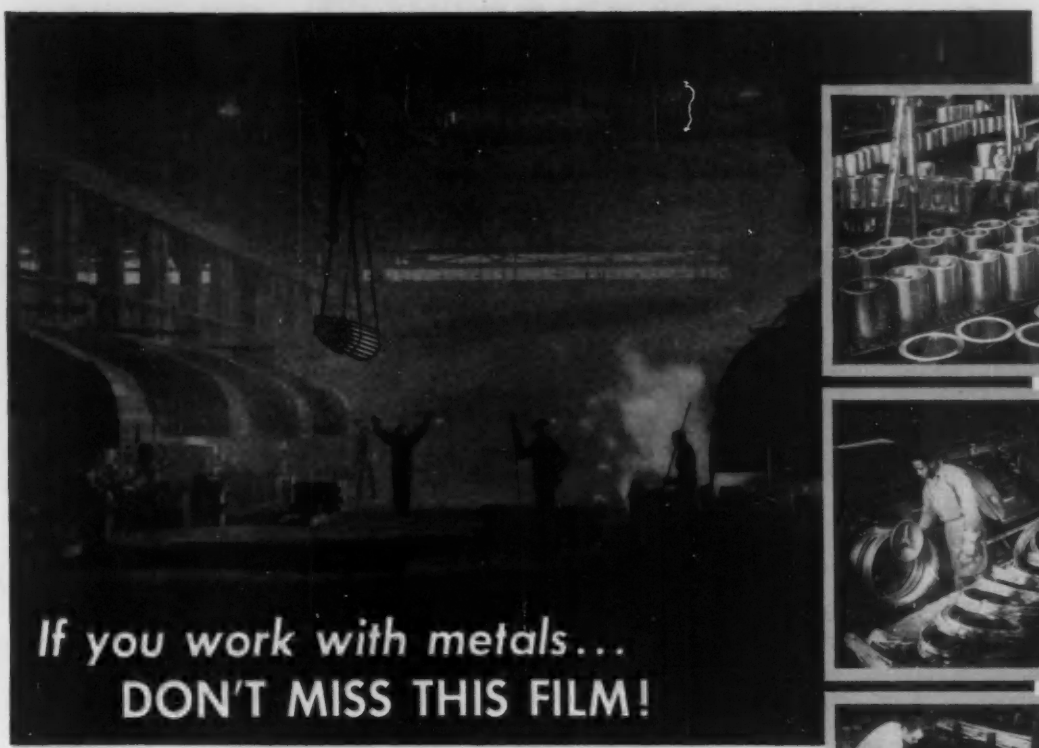
KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

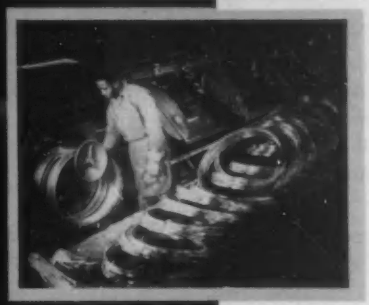
THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

K-5410

PRECISION BALL AND ROLLER BEARINGS





The prize-winning 16 mm color movie— "THE SCIENCE OF MAKING BRASS"

"In 30 minutes I learned more about making brass than in a day's trip through the mill."

That's a typical reaction to this dramatic Chase film! "The Science of Making Brass" takes you on a guided tour of Chase mills—shows you exciting, full-color close-ups of every step in the making of brass and other copper alloys in the form of sheet, rod, wire and tube. If *you* work with metals, it's an experience you won't want to miss!

"The Science of Making Brass" is a 16 mm, full-color film with a running time of 29 minutes, and will be loaned to you on request. To arrange a showing, clip and mail the coupon below.

It won these PRIZES First Prize, International Competition for Technico-Industrial Documentary Films, Turin, Italy and Venetia Diploma at Venice Festival.

It won this PRAISE "Far superior..." (Colorado manufacturer) "Excellent in every respect..." (Large eastern manufacturer) "Finest ever seen..." (Texas distributor).

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To: Chase Brass & Copper Co., Incorporated
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Gentlemen:

_____ *Please send me more information on your 16 mm, full-color film, "The Science of Making Brass."*

_____ *I would like to arrange for a showing on or about* _____

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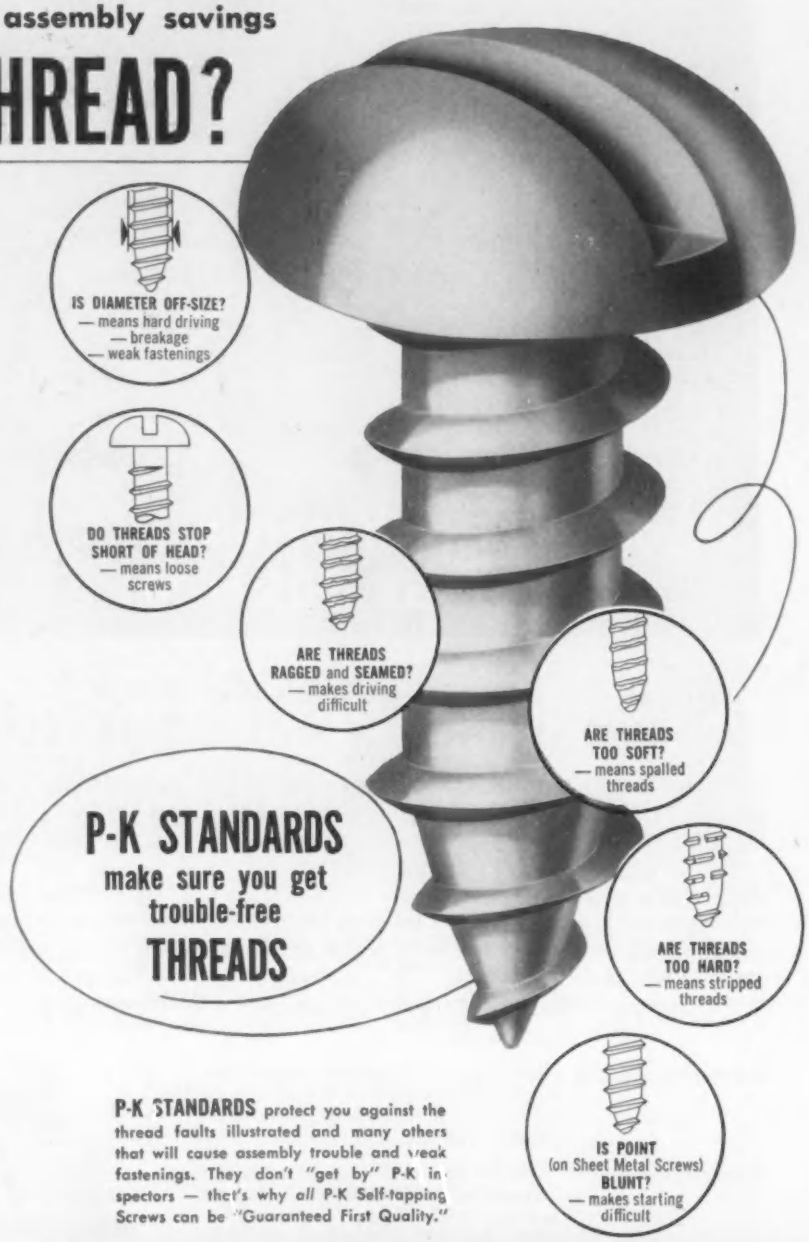
Are You BARRED

from planned assembly savings

BY A THREAD?



No MATTER how carefully you plan to take advantage of the proved speed and simplicity of the self-tapping screw *method,* your planning won't pay off if "softies" and "cripples" turn up among the screws you use.

Screws can be "trouble-bent" in many ways. Like the thread faults listed here, most are invisible, but their effects (job slowdown, parts spoilage, high reclamation expense, hidden weakness) show up clearly in mounting assembly costs and customer complaints.

That's why P-K quality standards have been set so high — to make sure you get Self-tapping Screws that are not only threaded, but headed, pointed, and heat-treated with one purpose in mind, to keep your assembly lines trouble-free.

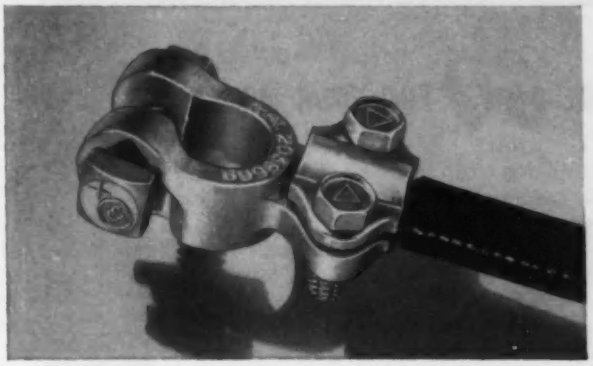
P-K Self-tapping Screws are the leading choice of experienced specialists who plan assembly of America's best known products. Follow their lead . . . for day-in, day-out dependability, specify P-K. For information on any fastening problem, talk to a P-K Assembly Engineer . . . Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14. Chicago Warehouse, 4331 West Lake St., Chicago 24.

P-K STANDARDS protect you against the thread faults illustrated and many others that will cause assembly trouble and weak fastenings. They don't "get by" P-K inspectors — that's why *all* P-K Self-tapping Screws can be "Guaranteed First Quality."

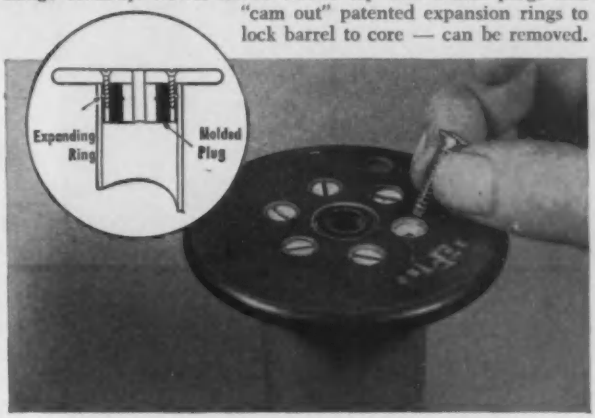
PARKER-KALON

IN STOCK . . . see your nearby P-K Distributor . . .

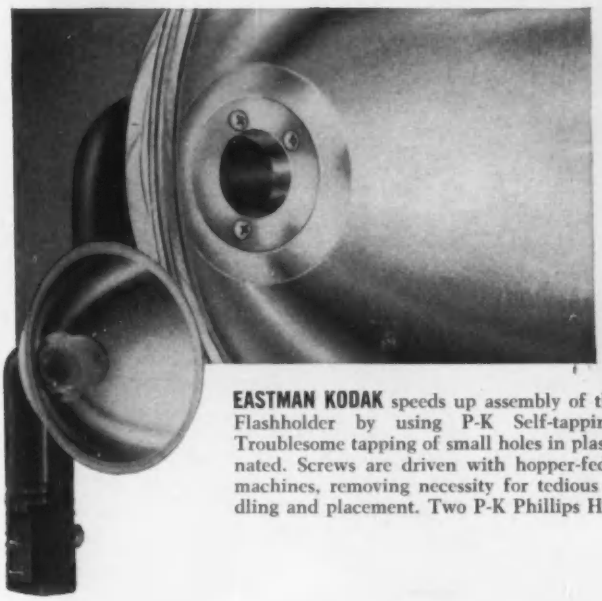
SOLDERLESS BATTERY TERMINAL assembly by Triple-A Co. was reduced from 5 to 2 operations when P-K Hex Head Type F Screws were adopted as clamp fastenings. Screws clear cored holes as they are driven by automatic machines — eliminate drilling, tapping, and awkward screw handling. They provide firm, sure grip on terminal, yet can be removed and replaced if necessary.



EPI BOBBINS, products of Engineered Plastics, Inc., must withstand extreme end pressure of nylon and other synthetic yarns under tension. Six P-K Type F-Z Screws fasten each laminated phenolic flange securely. Power-driven screws tap into Durez plugs and "cam out" patented expansion rings to lock barrel to core — can be removed.



with P-K quality-planned assembly savings pay off



EASTMAN KODAK speeds up assembly of the Kodalite Flashholder by using P-K Self-tapping Screws. Troublesome tapping of small holes in plastic is eliminated. Screws are driven with hopper-fed automatic machines, removing necessity for tedious screw handling and placement. Two P-K Phillips Head Type F Screws fasten a cover mounting bracket to the flashholder case (right) and three more fasten the metalized Tenite II reflector to the case (left). Case is a thermo-setting phenolic. Screws hold firmly under all stresses of normal use, can be removed for attachment of new reflector.

The First originated by P-K . . . and First Today . . . the leading choice for fastening economy

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Designed and engineered to be the finest you can buy, Aetna bearings and parts give you real economy through highest quality . . . help your products deliver more "go," more efficiency, longer life, greater satisfaction to the user. Choose from our complete line of standard ball thrust bearings (catalog on request) or send us your blueprints if your requirements involve special bearings or hard-to-make precision parts. Engineering assistance, experimental work and quotations promptly rendered without obligation.
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Careful metallurgical control is imperative to assure the attainment of the desired properties in stainless steel tubing, particularly workability. Bishop assures this by inspecting chemically, metallurgically and visually each requirement against customer specification.

J. Bishop & Company, the first American company to successfully draw small diameter stainless steel tubing specializes in small diameter tubing (.008"-1" O.D.). Bishop's 25 years' experience in stainless steel tubing and 113 years' experience fabricating precious metals are your assurance of precision fabrication and quality craftsmanship.

The next time, particularly if workability is important, specify Bishop stainless steel tubing and be sure. Catalog on request.

If you buy stainless steel fabricated tubular parts, or fabricate parts yourself from stainless tubing, investigate Bishop's cost-reducing "under one roof" drawing and fabricating facilities. You'll save more.

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ON LAND, SEA AND AIR

LORD Flexible Couplings

TRANSMIT THE FULL POWER OF BOEING TURBINE ENGINES

HERE again you see at a glance Lord versatility in designing bonded-rubber components for a wide diversity of machines. The photo at top right shows the Boeing Gas Turbine-Driven Truck-Trailer for heavy cargo hauling. At the top left you see a United States Navy personnel boat driven by the Boeing Gas Turbine Engine. Directly beneath is the Kaman Helicopter powered by the Boeing Gas Turbine Engine; details are clear in the foreground. The Lord Bonded-Rubber Flexible Coupling designed for the job transmits the power in each machine.

Special requirements like these reach satisfactory and economical solutions at Lord, Headquarters for Vibration Control. We invite you to take advantage of more than a quarter century of design experience and craftsmanship.

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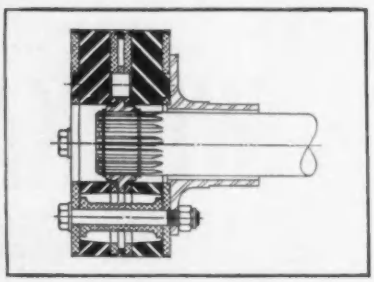
LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

(*Advertisement*)

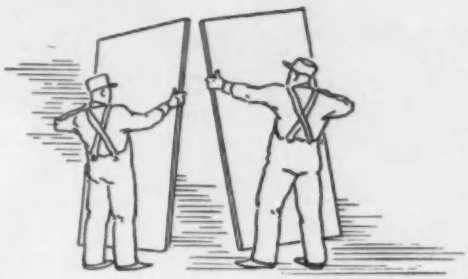
Lord Flexible Coupling Flies With Kaman Helicopter

The Kaman K-5 helicopter presents an interesting application of the LORD J-5329-2 flexible coupling with the Boeing 502-2 gas turbine. The function of the coupling in this case is to absorb the torsional vibrations of the system and isolate the turbine from the rotors. However, the unit also serves to accommodate angular or parallel misalignments due to manufacturing tolerances or dynamic motions.



The unique design of the installation provides maximum accessibility and economical maintenance through the use of concentric driving and driven shafts. The inner member of this pair is the engine shaft which drives the coupling hub through a splined connection. Precompressed against the splined hub are the two bonded rubber coupling halves which transmit the engine torque in shear of the rubber. Four through-bolts connect the outer plates of the coupling halves to the driven hub and also serve as the safety interlock in case the rubber sections are destroyed. The first gear of the transmission is mounted on this driven hub and feeds power on through the system in to the helicopter rotors.

For over thirty years the Lord organization has specialized in designing and producing Bonded Rubber Flexible Couplings, Vibration and Shock Control Mountings and Component Parts. The capabilities of Lord Engineering have proved their worth to designers of industrial and automotive equipment in many diversified fields as is indicated in this instance.



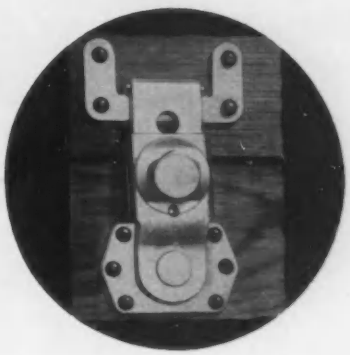
Have you a similar fastening problem?

How a strong structure can be designed for speedy and simple assembly with unskilled labor, no special tools...

The U. S. Air Force wanted a jet-aircraft hangar design that would be portable by air, yet strong; would assemble quickly; be interchangeable, and flexible enough for easy structure modification.

The answer lay in a panel structure using modular units. Armorply honeycomb panels faced with thin aluminum, developed by United States Plywood Corporation, provide lightness, strength, flexibility. Joining one panel to the other in the field with untrained help was a problem until Simmons Fastener developed LINK-LOCK, a simple latching device that operates with minimum wrench pressure on hex nut.

This fastening problem is being successfully met by combining the design ingenuity of No. 1 LINK-LOCK with the proved performance of honeycomb plywood panels.



No. 1 LINK-LOCK—like No. 2 LINK-LOCK—features simplicity, positive action, high strength.

No springs are used in No. 1 LINK-LOCK. Locking action is obtained by rotating a nut that moves a sliding latch in and out of position. Up to 1500-lb. pull-down pressure is available; the device carries up to 4000-lb. tension. No. 1 LINK-LOCKS provide for surface mounting, simplifying installation.

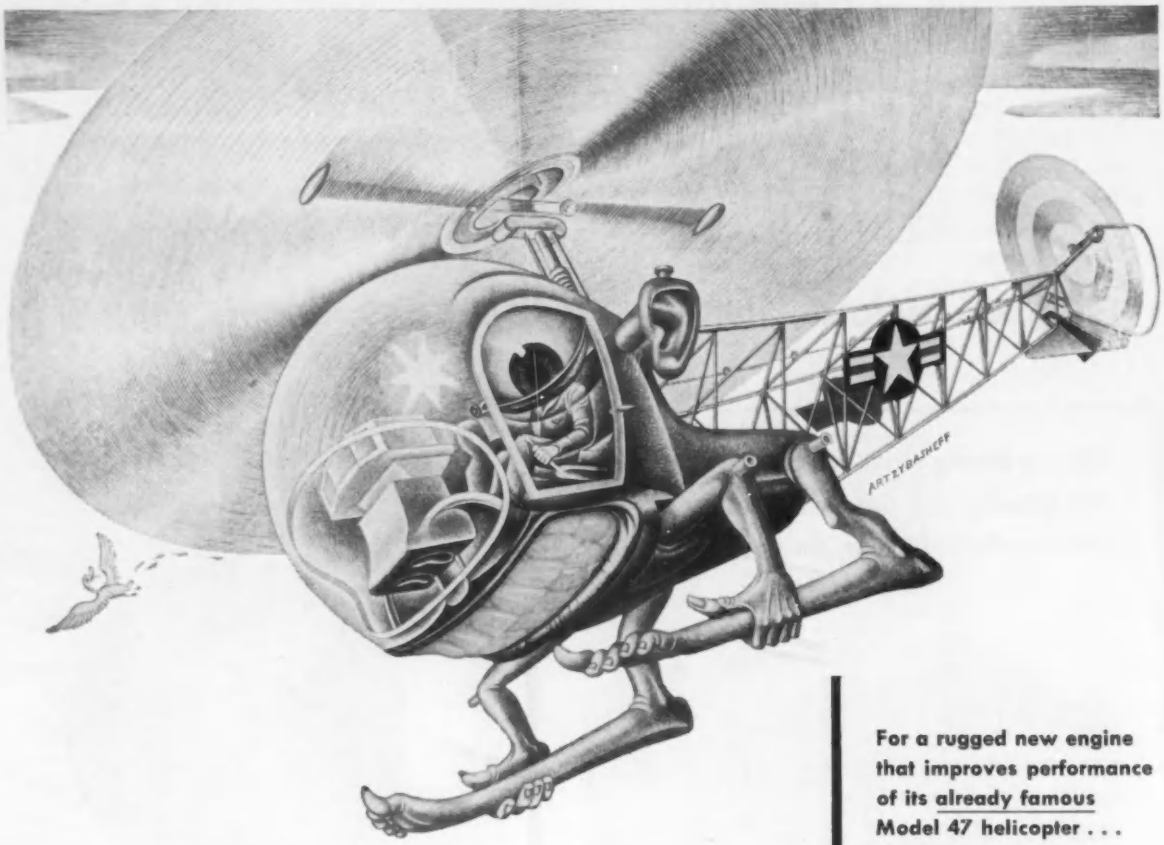
Where can you use it? When you need heavy fastening pressures, resistance to impact, operation in 70-below temperatures—and where ease of action, compactness, and low cost are important factors. Write for a No. 1 LINK-LOCK Data Sheet.

SIMMONS FASTENER CORPORATION
1751 No. Broadway, Albany 1, New York

Simmons

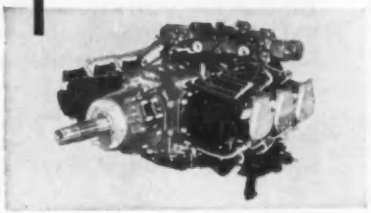
LINK-LOCK
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK

FASTENERS THAT IMPROVE PRODUCTS AND REDUCE ASSEMBLY COSTS



For a rugged new engine that improves performance of its already famous Model 47 helicopter . . . and reduces maintenance as well . . . BELL looks to Lycoming.

New "vitals" for this Korean air vet



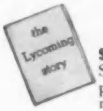
This battle-proven hero of 18,000 front-line rescues over Korea is now *outperforming itself*—newly powered by Lycoming's 250-h.p. O-435 engine.

With this superior power plant, both the Model 47 and its sister ship—the 4-Place Utility 47G-1—will fly faster and higher in all weather . . . and require far less maintenance.

Such performance improvement is but one of many Lycoming contributions to air-cooled power.

Design engineers please note.

Can you use superior air-cooled power . . . or any other of the diversified services listed at the right of our signature? *Whatever* your problem . . . look to Lycoming!



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DIVISION OF AVCO STRATFORD, CONN.
Manufacturing plants in Stratford, Conn., and Williamsport, Pa.

• Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example . . .

THE PARAGON® DRAFTING MACHINE

Thorough knowledge and thorough care of minutest detail were essential to the designing of the sturdy, accurate Paragon® Drafting Machine. Draftsmen prefer the Paragon, because it is time-saving and work-sparing, because it is reliable, easy to operate, and because they don't have to treat it with kid gloves. The Paragon Drafting Machine increases drafting room efficiency enormously, and effects substantial economies.

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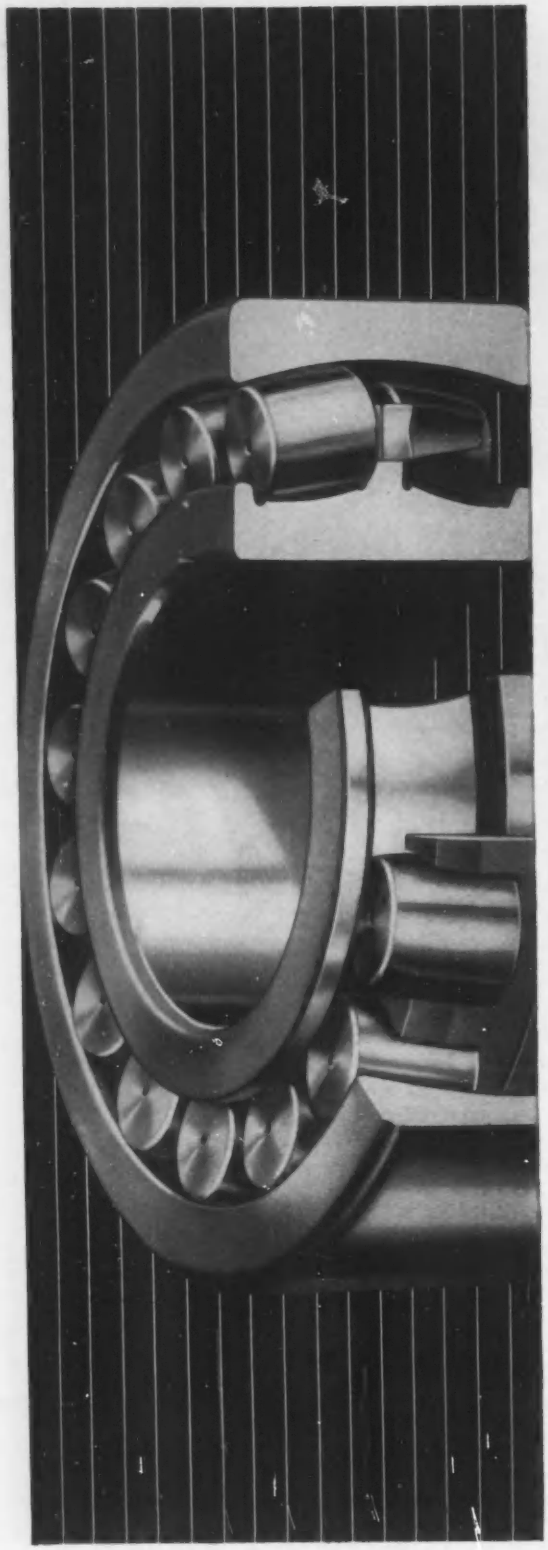
Chicago • St. Louis • Detroit • San Francisco • Los Angeles • Montreal
Distributors in Principal Cities

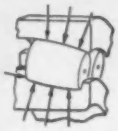


why it pays to specify

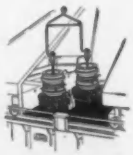
TORRINGTON

Spherical Roller Bearings

Uniform, close control of precision-ground contact surfaces—for even load distribution and maximum bearing life.



Accurate geometrical conformity between races and rollers—for ultimate load carrying capacity and performance.

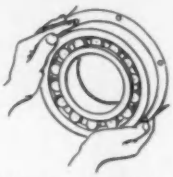


Races and rollers heat treated according to the most advanced metallurgical procedures—for maximum durability.

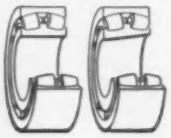
Individual one-piece cage for each path of rollers—assures freedom of operation.

Integral flange on inner race—to give radial stability and positioning for thrust loads—both essential to satisfactory performance.

Self-aligning—for continuous, free-rolling service under shock loads and at sustained speeds.



Unit assembly—for easy, economical handling.



Available from stock with either straight or tapered bore—for shaft or adapter mounting.

These are advantages that give you long, efficient, low-maintenance service in the toughest heavy-duty application. **To get maximum value for your bearing dollar, *specify TORRINGTON Spherical Roller Bearings.***

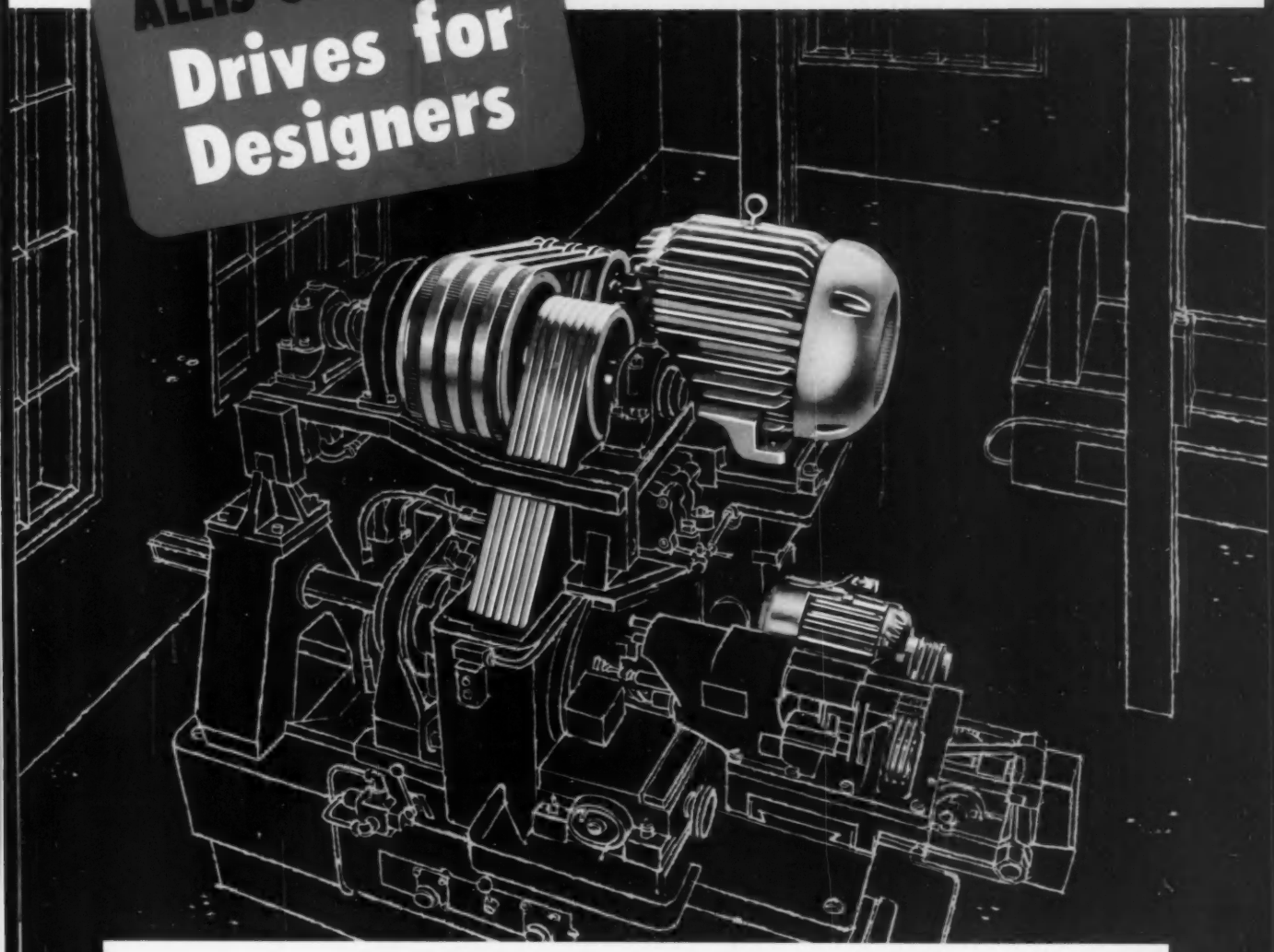
THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON SPHERICAL ROLLER BEARINGS

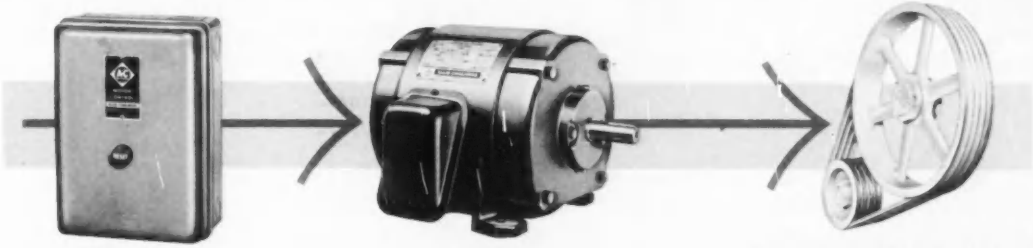
Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

ALLIS-CHALMERS Drives for Designers



One Reliable Source for...

Everything from Power Line to Driven Shaft



Control | Motor | Texrope V-Belt Drive

A-4515

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Simplify YOUR DRIVE DESIGN PROBLEMS

Save Engineering Time and Cost

Select all components for your complete drive . . . motor, control and *Texrope* V-belt drive . . . from one source. Ratings are coordinated to make selection easier. Parts match up properly because they are made to the same engineering and manufacturing standards.

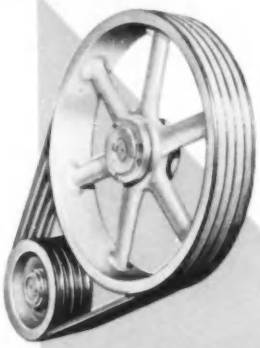
Cut Purchasing Problems

One source means less paperwork . . . fewer orders to issue and follow up . . . coordinated deliveries . . . less expediting.

Reduce Manufacturing Costs

Parts fit together easily at assembly because they are designed and built to be used together . . . to fit a single set of standards. And, of course, you have one responsibility for the performance of the complete drive unit . . . one reliable guarantee of satisfaction.

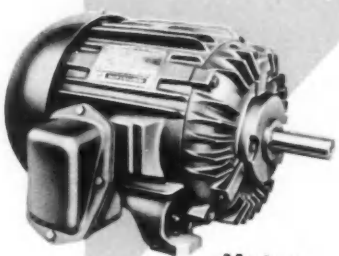
Texrope, Magic-Grip and Vari-Pitch are Allis-Chalmers trademarks.



Texrope V-Belt Drive

Everything from Power Line to Driven Shaft

Control



Motor

Get This New Drive Bulletin

This 16-page booklet shows the complete range of Allis-Chalmers power package products plus all-electric package drives and pumps for coolant pumping and air conditioning. For your copy, ask your Allis-Chalmers District Office or write — Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 25B7110.

Texrope Drives

- *Texrope* standard and high capacity V-belts.
- *Magic-Grip* sheaves.
- *Vari-Pitch* variable speed sheaves for stationary or motion control.

More and more designers are finding that the moderate cost of *Vari-Pitch* sheaves is returned many times in increased machine versatility and more precise quality control. With *Vari-Pitch* sheaves, speeds can be accurately adjusted quickly and easily over a wide range.

Motors

- Special and modified standard design motors.
- Drip-proof, TEFC and explosion-proof motors.
- Squirrel-cage, wound-rotor, synchronous and direct current motors from ½ hp up.
- Motors for single, multiple or variable speed operation.

Reduced maintenance of the dirt-shedding TEFC fin-type design is making it very popular for machine tool applications.

Motor Control

- Standard and special starters from size 0 up.
- Variable speed control for wound-rotor and direct current motors.
- Standardized package drives, machine tools and other multiple variable speed motor applications.

A-C ALLIS-CHALMERS

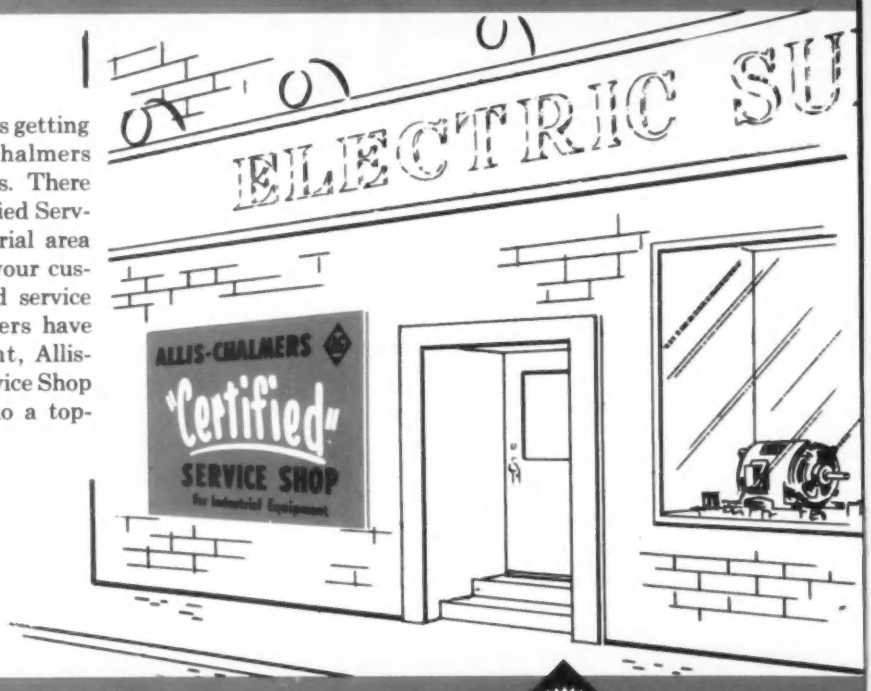
ALLIS-CHALMERS

SERVICE before you buy

Your Allis-Chalmers field application engineer will be pleased to give you as much engineering help as you want or need. And, because Allis-Chalmers builds many types of power-driven machinery, he's familiar with design and manufacturing problems as well as those concerning specialized motor, drive and control applications.

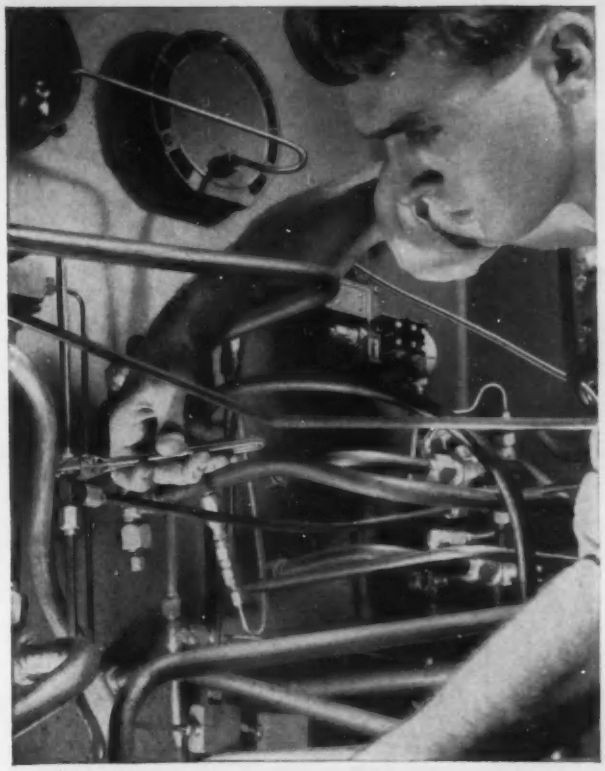
SERVICE after you buy

Your customers will have no problems getting competent service on the Allis-Chalmers components used in your products. There are nearly 100 Allis-Chalmers Certified Service Shops, located in every industrial area of the country. These shops offer your customers factory-approved parts and service methods. And — if your customers have special Allis-Chalmers equipment, Allis-Chalmers will give the Certified Service Shop all the information necessary to do a top-notch service job.



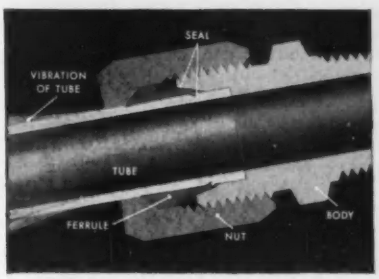
ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

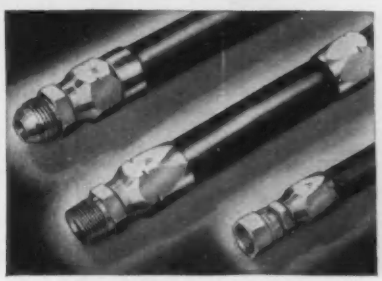


"Tube up and forget it" with leakproof Parker fittings

Triple-lok flare fittings are the easiest, fastest and safest way to tube up even in close quarters. They are absolutely leakproof even under the severest conditions of vibration, high pressures and temperatures. *Triple-lok* fittings meet J.I.C. and S.A.E. Standards plus specifications of the A.S.M.E. Code for Pressure Piping. Available for tubing outside diameters from ⅛ through 2 inches. More *Triple-lok* fittings are used on industrial machinery than any other fittings.

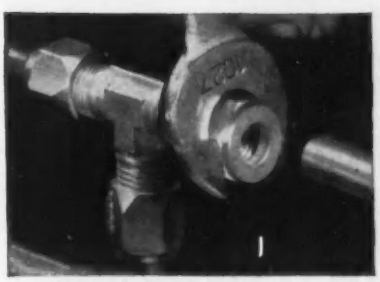


Ferulok flareless fittings, featuring the visible "bite", are especially for high-pressure, heavy-wall tubing. Cutaway shows why vibration won't break the seal.

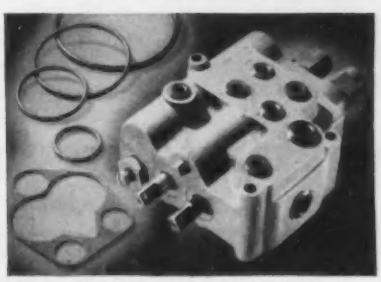


New Hoze-lok fittings and hose assemblies (for medium and high-pressure hydraulic service) offer better performance, easier make-up, greater re-usability.

New Weld-lok fittings are machined from high-quality steel or stainless-steel bar stock and forgings. They are available for tubing ¼ through 2 inches, O.D.



New Intru-lok tube fittings can be quickly installed by anyone. Simply push tube in, then tighten nut. Designed for instrumentation lines of ¼ through ½ inch, O.D.



Other Parker products include new hydraulic control valves, check valves, accumulators and O-rings. Mail the coupon for the fitting catalogs you want.

TUBE AND HOSE
FITTINGS DIVISION
Section 411

The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

- ☐ Send Triple-lok & Ferulok Catalog No. 4300
- ☐ Hoze-lok Catalog No. 4400
- ☐ Weld-lok Catalog No. 4370
- ☐ Intru-lok Catalog No. 4320A1

Name _____ Title _____
Company _____
Address _____
City _____ State _____

Parker
Hydraulic and fluid system components

large

55-gallon drums one-piece molded from BAKELITE Polyethylene are designed to fit in standard fiber, plywood, or steel overpacks. Chemically inert, they resist acids, caustic soda solutions, electrolytic fluid. Resilient, non-shattering, lightweight, they increase safety, cut shipping costs.

small

Tubes and bottles molded from BAKELITE Polyethylene dispense their chemical and pharmaceutical contents when squeezed. Inherently flexible, polyethylene needs no plasticizer. It won't contaminate contents. Tube ends are closed by heat-sealing.

thick

Coaxial cable has thick layer of BAKELITE Polyethylene around center conductor and covered by outer conductor. Tough, flexible, and possessing excellent electrical insulating qualities at high frequencies, polyethylene insulates conductors and keeps them correctly spaced. Other extrusions include belts, tapes, tubes, farm water pipe.

or thin

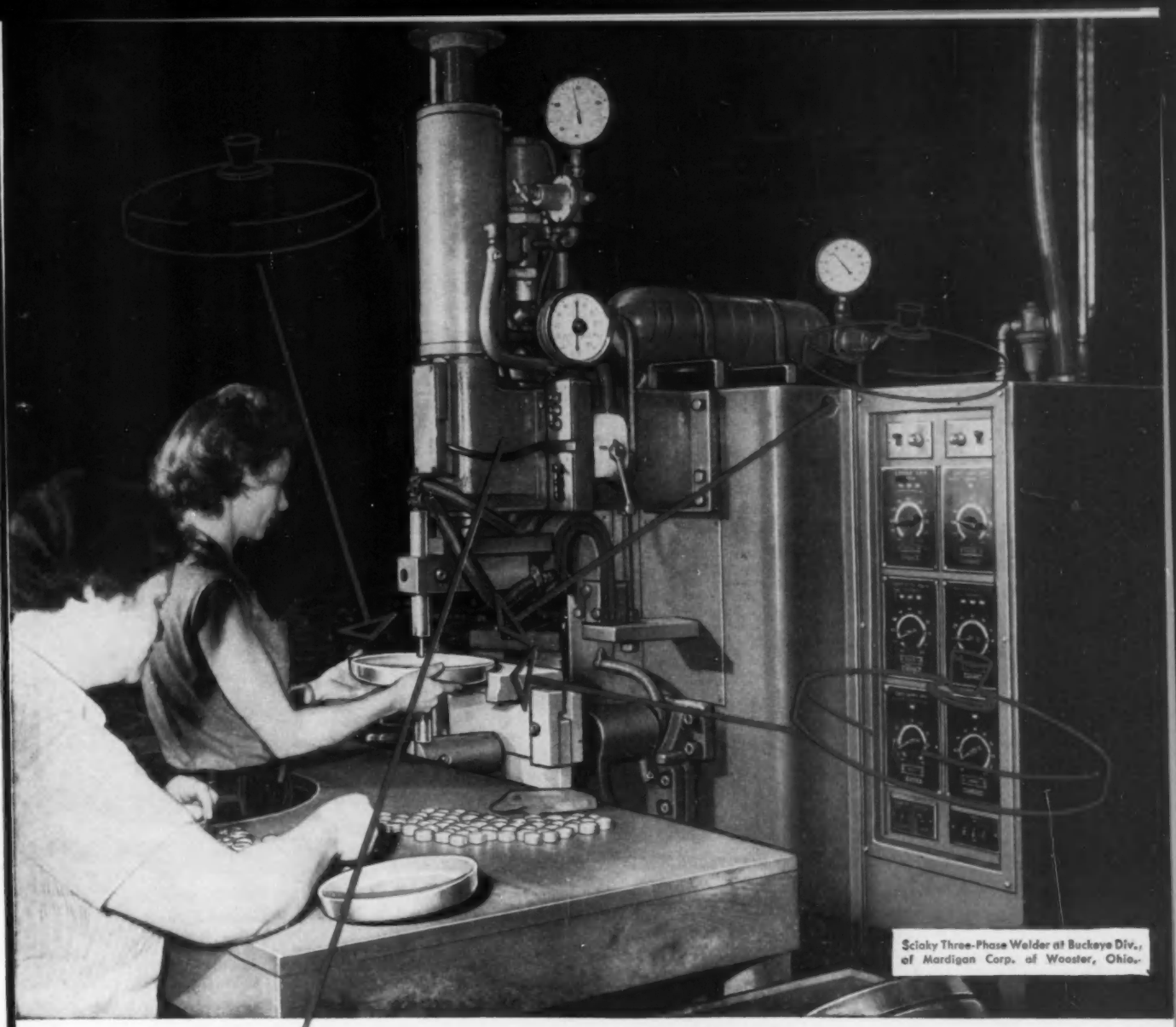
Liquids are being packed in laminations of cellophane or foil with film made from BAKELITE Polyethylene. Advantages: added toughness and tear strength, heat-sealing to a strong, watertight bond, and resistance to food and other chemicals.

add a new dimension to product planning—

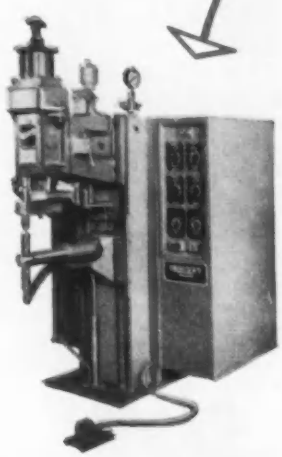
BAKELITE TRADE-MARK Polyethylene

Open a new range of performance features for your product. Give it advantages that mean greater sales. Take your pick of fabrication methods—injection molding, extrusion, calendering, coating, vacuum-forming. BAKELITE Polyethylene is packed with possibilities—and it's in plentiful supply right now. The first step in your planning is to learn more about it by writing Dept AJ-10.

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario



Sciaky Three-Phase Welder at Buckeye Div., of Mardigan Corp. of Wooster, Ohio.



Sciaky Three-Phase Improves Design, Appearance, and Jumps Production 375%

The use of Sciaky patented Three-Phase balanced load, high power factor, resistance welding **enabled Buckeye to improve the design and jump production 375% on pot and pan covers.** Sciaky Three-Phase readily solved a limited power problem. **Fabricating costs were reduced sharply, and the basic design of the product was greatly improved.**

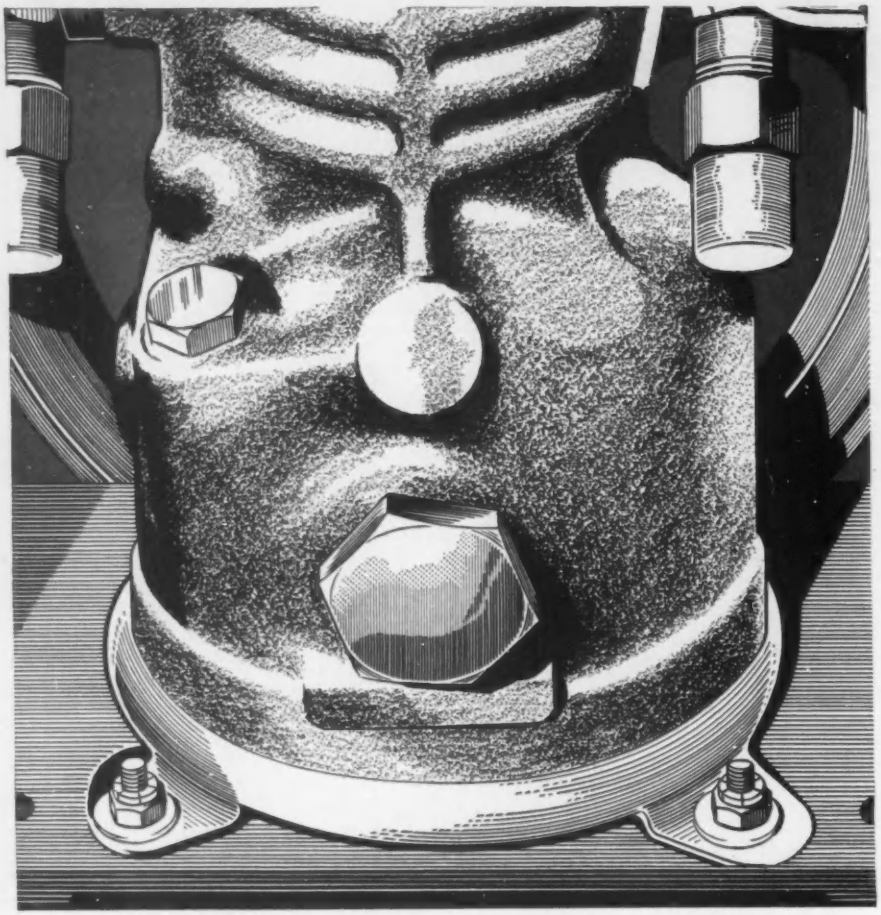
In welding, a disc and a drawn .025 aluminum cup are placed over the lower spot welding electrode. The .104 aluminum cover is inverted over the cup and one stroke of the welder completes the assembly. Then the hollow knob is screwed into place completely covering cup and flush with the cover. The airspace within the knob protects miladies' fingers from burns. Write for complete details of the welding operation at Buckeye in "Resistance Welding at Work," Vol. 4 - No. 2.

Buckeye's improved design for cover knobs is another fine example of Sciaky basic thinking — welders designed to do *more useful work* at *lowest operating cost* with *maximum reliability.*

Largest Manufacturers of Electric Resistance Welding Machines in the World

SCIAKY

Sciaky Bros., 4913 West 67th Street, Chicago 38, Illinois

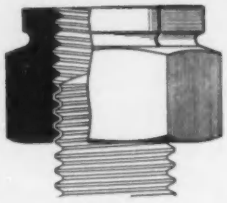


Many manufacturers use FLEXLOCS to fasten motors, compressors and other vibrating equipment to mounting plates. FLEXLOCS won't work loose... they eliminate costly service calls.

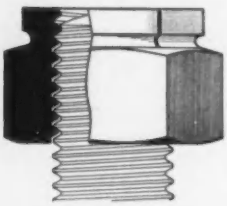
FLEXLOC locknuts reduce costly service calls

FLEXLOC locknuts do this because they stay put anywhere on a bolt as soon as their locking threads are fully engaged. Even the most severe vibration will not work them loose. FLEXLOCS offer many other advantages, too. *They are one piece.* They eliminate complicated, time-consuming methods of locking studs and bolts. They provide simpler, faster application and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, nuts and jam nuts. They save buying, stocking and handling of extra parts. *They are all metal.* They have higher tensile strength than most other lock nuts. They permit you to stock only one nut for all temperatures to 550°F. *They are reusable.* They can be applied again and again without losing locking efficiency—a plus value in maintenance.

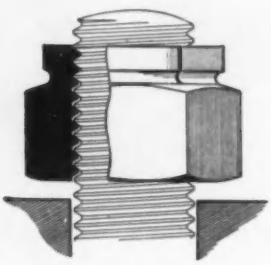
For information about FLEXLOCS and samples for test purposes, see your FLEXLOC distributor or write STANDARD PRESSED STEEL CO., Jenkintown 28, Pa.



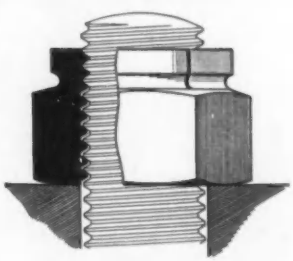
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC® LOCKNUT DIVISION

SPS JENKINTOWN PENNSYLVANIA

Completely new Bullard Cut Master V.T.L. Model 75 uses TIMKEN® bearings to insure extra load capacity, top precision

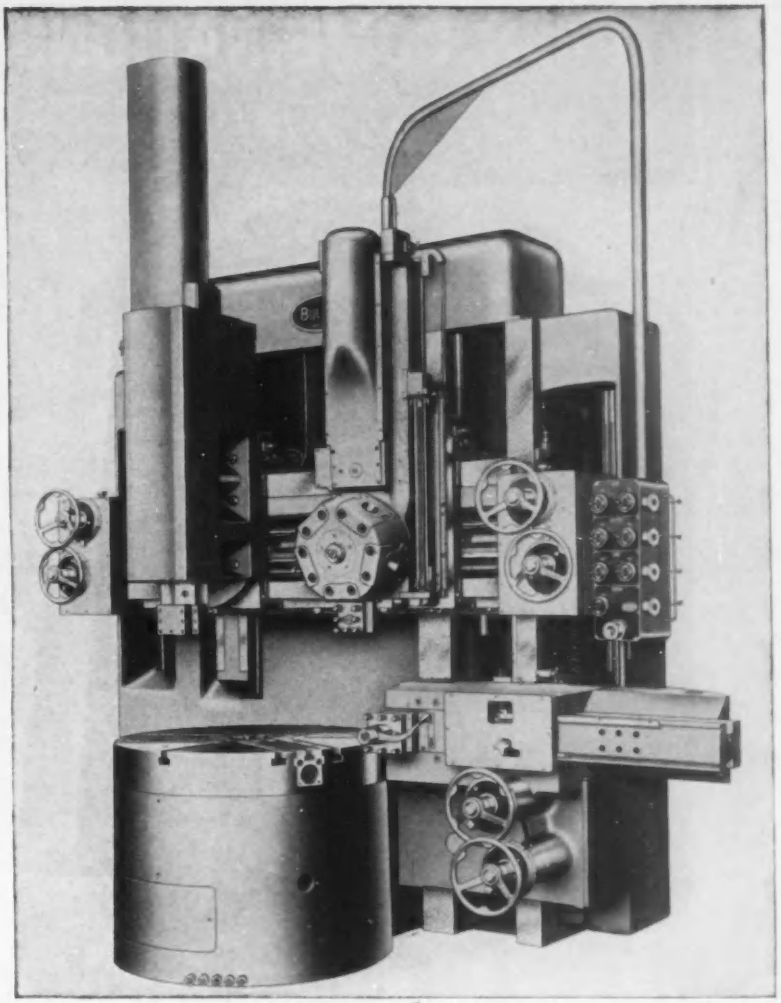
TO reduce power losses and provide highest efficiency at point of cutting, The Bullard Company engineers chose Timken® tapered roller bearings for the Bullard Cut Master Model 75, a completely new design of vertical turret lathes. Timken bearings are used in the table, headstock, feed and traverse mechanism, side, ram and turret head drives and other applications throughout the machine. They have been selected to meet the service requirements at each vital point with maximum efficiency. From 160 up to 196 Timken bearings are used according to the number and types of heads selected.

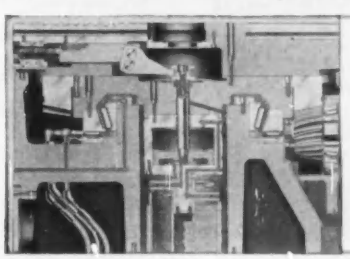
Timken bearings have extra load-carrying capacity that results from line contact between rollers and races. Tapered construction permits preloading, so deflection is kept to a minimum, and constant accuracy is maintained. Radial and thrust loads can be carried in any combination. Timken bearings are geometrically designed to roll true and precision manufactured to live up to their design. They hold shafts in rigid alignment, insure accurate gear mesh.

We take every step possible to make Timken bearings the best. We even make our own steel so we can control quality from beginning to end. We're the only U.S. bearing manufacturer that takes this extra step.

Make sure the machines you build or buy have bearings with the trademark "Timken". They're number one for value. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best





BULLARD design of table bearing construction uses Timken tapered roller bearings for long life, trouble-free performance.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST → LOADS OR ANY COMBINATION →

660
TIMER COMBINATIONS
...So far!

PERHAPS YOUR TIMER WILL BE THE 661st

How do you know we can supply you with the timer that will do your job best? Because we have 19 years of experience in developing new timers to meet our customers widely varied requirements. If one of our standard timers won't do it–or one of the 660 combinations we have thus far developed from our 17 basic units–our engineers will develop the 661st combination, for your specific needs.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • INTERVAL TIMERS
RE-CYCLING TIMERS • RUNNING TIME METERS

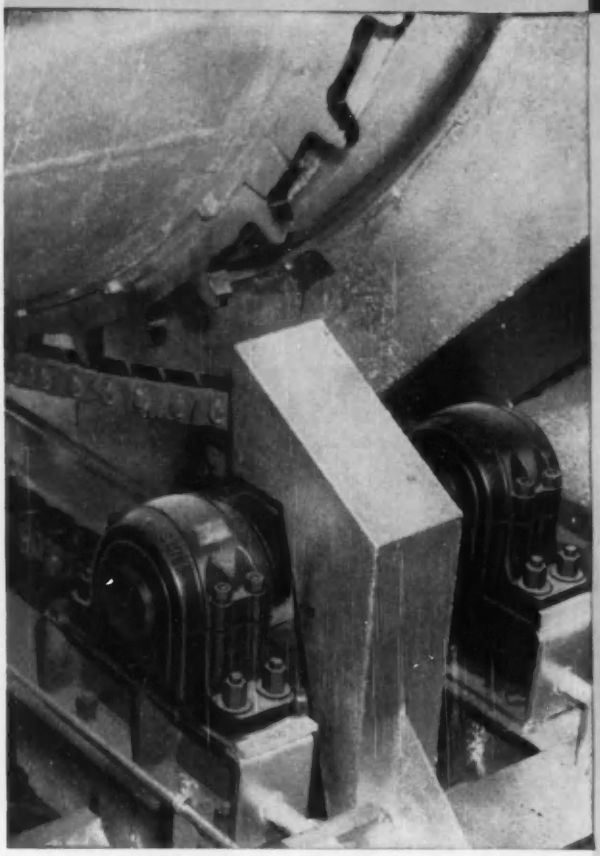
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries–and of good deliveries even on special orders. Automation? We're in it up to our ears...just put your problem up to one of our timer specialists. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

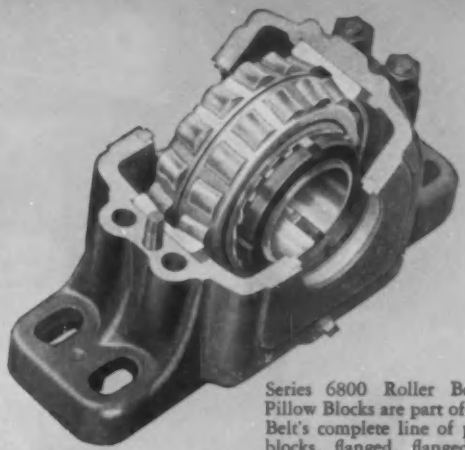
INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

TOUGH JOB?

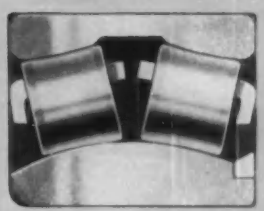


Two Link-Belt Series 6800 roller bearings provide free rolling for huge asphalt drum drives. For chain drives, elevator chain, buckets and other related equipment, F. D. Cummer has long relied on Link-Belt as their sole supply source.

READY ANSWER:



Series 6800 Roller Bearing Pillow Blocks are part of Link-Belt's complete line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings.



INTEGRAL SELF-ALIGNMENT Concave rollers operate between convex raceways. Inner ring is true spherical element, free to align in any direction without altering contact with rollers. Symmetrical rollers completely pocketed in retainers for accurate spacing and guiding.

GREATER STRENGTH, LESS WEIGHT AND BULK. Block base is cored to provide uniform metal thickness, assuring a sound casting, free from distortion.

LINK-BELT bearings used exclusively for almost 20 years by F. D. Cummer & Son Co.

BEARINGS that can withstand the shock loads, high temperatures and abrasive grit common in an asphalt plant are indeed proof of sound engineering and top quality. So efficiently have Link-Belt bearings performed in this type of service that F. D. Cummer & Son Co., Cleveland, manufacturers of fine asphalt plants, has used them exclusively for all their shaft support requirements for nearly 20 years.

Heavy-duty Series 6800 roller bearings exemplify the design advancements that make precision-built Link-Belt ball and roller bearings first choice for America's hardest working equipment. From their ample reservoirs which prolong lubrication intervals to the compact, self-contained design—every detail contributes to long life and dependable performance. They are completely housing-sealed. Inherent self-alignment assures full load capacity even under shaft deflection or misalignment.

Talk over your bearing problems with a Link-Belt engineer. There is a size and type of Link-Belt bearing that is right for your requirements . . . and they can be supplied from factory branch stores and authorized stock carrying distributors. You can also get complete information by writing for 120-page Data Book 2550.

LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.6853

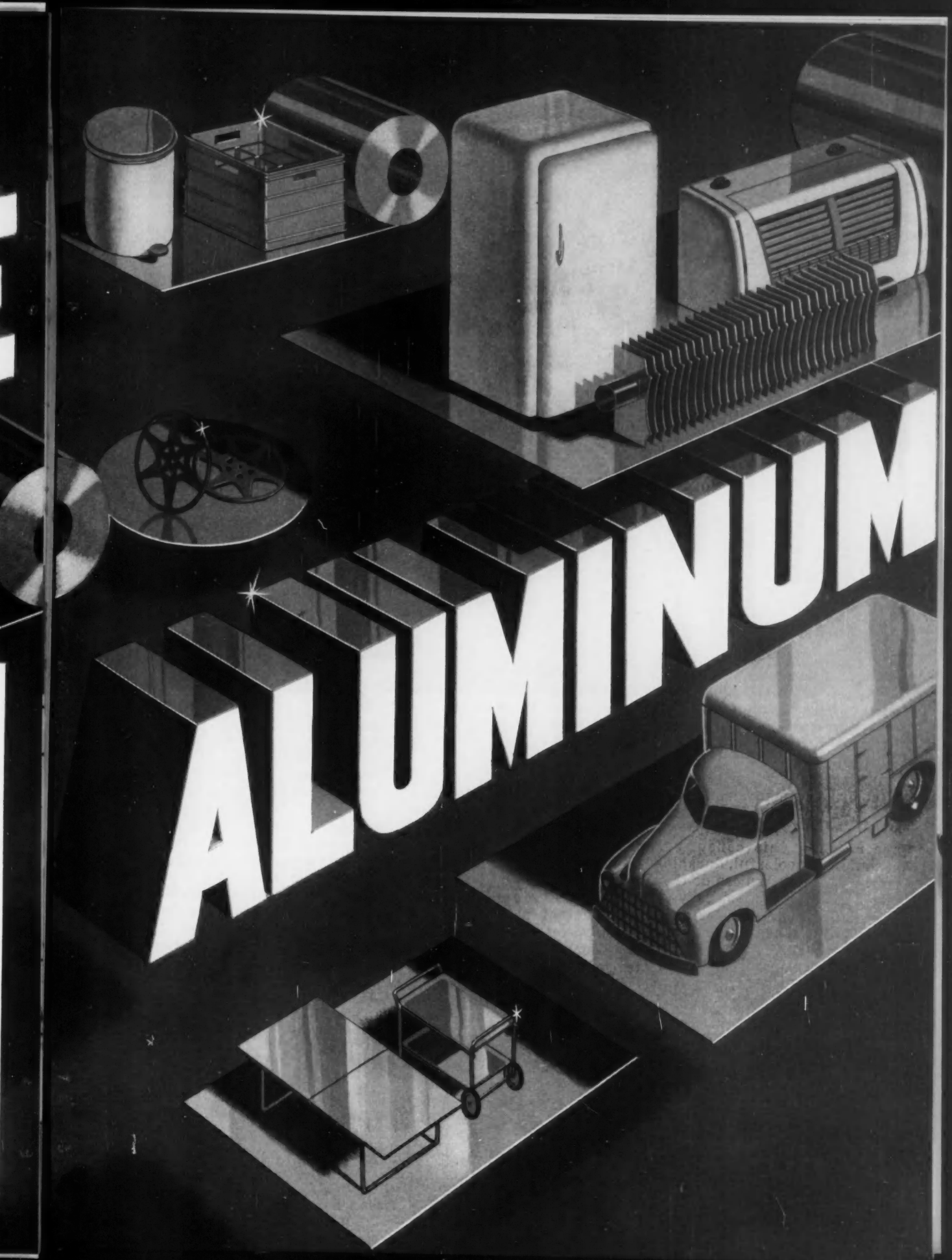
Today . . . competition-minded manufacturers on all sides are finding logical new reasons to use more and more aluminum sheet products. Aluminum's ready workability, corrosion resistance, strength, ease of welding and joining, and the way it lends itself to surface finishes of distinction—all very often combine to make it first choice in metals.

Revere can supply you, not only with a full line of aluminum sheet products, but with aluminum tube, extruded products, electrical bar, forgings and rolled shapes of the finest quality. Added to these are Revere's renowned copper and brass products which have been staples of American industry for more than 100 years.

REVERE KNOWS ITS A-B-C's

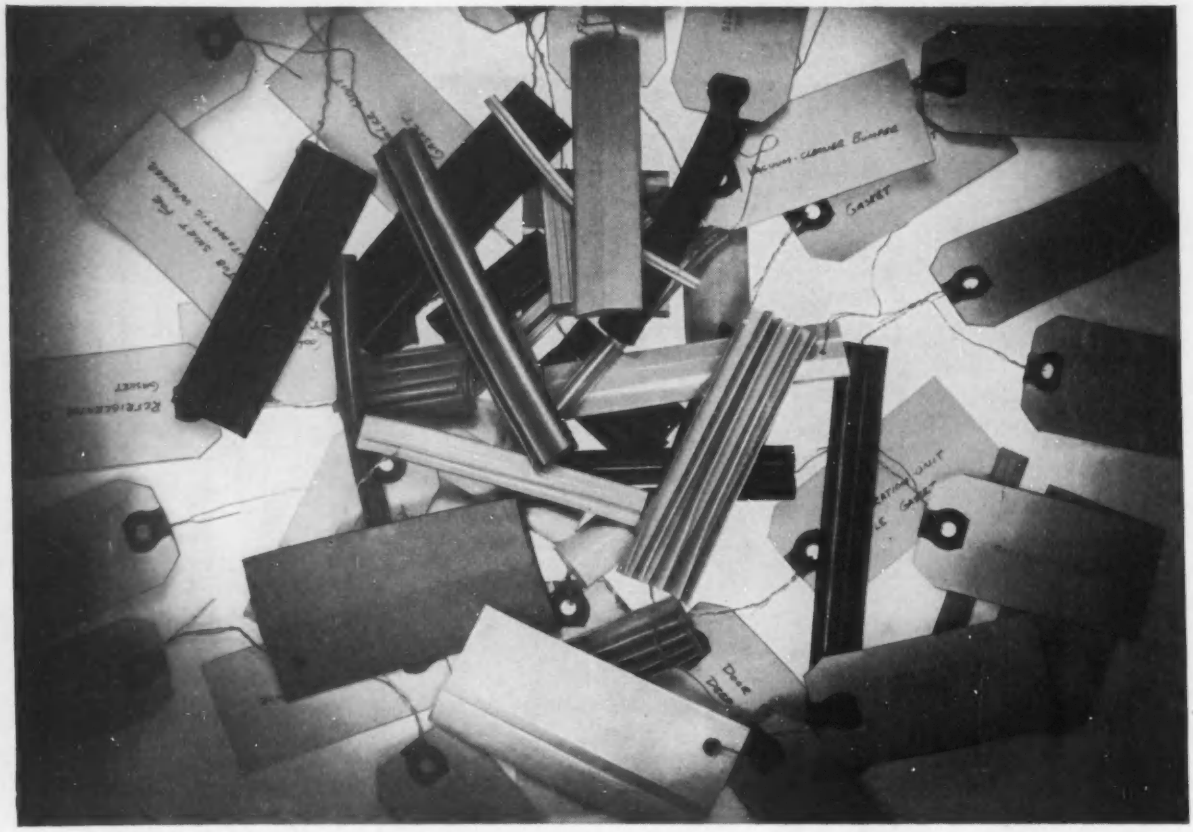
ALUMINUM BRASS COPPER

Why not add the Revere A-B-C's to your own alphabet of manufacturing knowledge and experience? Call Revere NOW. Revere Copper and Brass Incorporated, *Founded by Paul Revere in 1801*, Executive Offices: 230 Park Avenue, New York 17, N. Y.


ALUMINUM

Capture Color-Conscious Consumers

with custom extruded vinyl compounds



SHAPES OF THINGS THAT CAME to the aid of manufacturers seeking to increase the salability of their products are these attractively colored samples of functional, durable vinyl extrusions from Goodyear, St. Marys.

THE modern way to sell is with color. And many manufacturers—automotive, appliance and furniture, in particular—are meeting this consumer demand with colorful, durable vinyl extrusions. You can do the same—easily and economically—with the help of Goodyear and its recently expanded facilities at its big, modern molded and extruded goods plant in St. Marys, Ohio.

An unlimited range of colors—transparent, translucent or opaque—natural or metallic—is now readily available in unlimited cross-sectional design, unlimited lengths and unlimited quantities. Other outstanding properties include: A wide range in hardness. High strength. Excellent abrasion-, oil- and chemical-resistance. Low taste and odor levels. And again, low temperature and electrical properties comparable or superior to those of rubber.

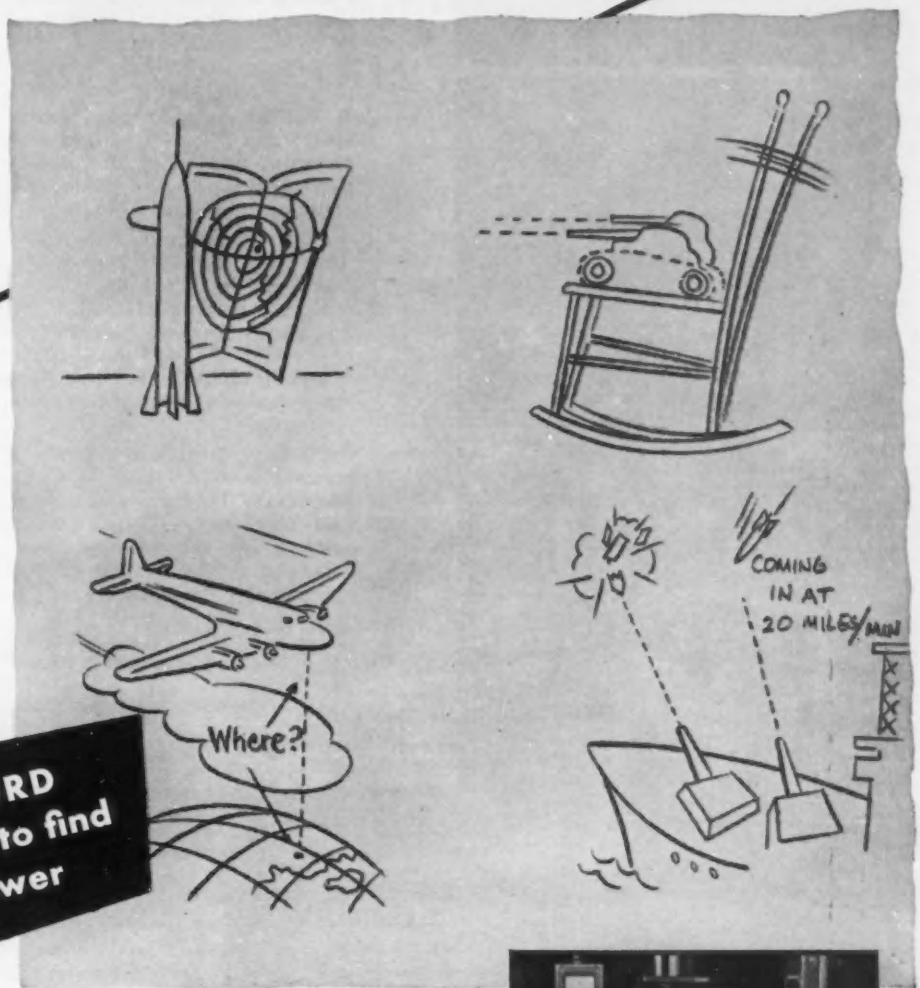
Most important, however, are the services and skills awaiting your call at St. Marys. An expert group of engineers, compounders and production workers is ready, willing and able to help you improve the sales appeal of your product with quality vinyl extrusions turned out with the finest equipment available. Details? Design assistance? Just write: Goodyear, Industrial Products Division, St. Marys, Ohio or Akron 16, Ohio.

GOODYEAR

THE GREATEST NAME IN RUBBER

We think you'll like THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

HOW CAN AUTOMATIC CONTROL
strengthen our defenses



...and FORD was asked to find the answer

MISSILE GUIDANCE . . . GUN STABILIZATION
AIRCRAFT NAVIGATION . . . WEAPONS SYSTEMS

The staff of engineers at Ford Instrument Company are experts in the field of automatic control. Every week, in the laboratories and shops of this large company thousands of men are working on electronic, hydraulic, mechanical and electrical servo-mechanisms, computers, controls and drives to solve problems for the Army, Navy and Air Force. Ever since Hannibal C. Ford started, in 1915, to develop and build the first gunfire computer for the U.S. Navy, Ford Instrument has been leading the way in applying the science of automatic control to America's defensive strength . . . and to American industry.

Each year the Ford Instrument Company is adding to its staff of several hundred engineers. If you are an engineer and can qualify, there may be a position for you.

34

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

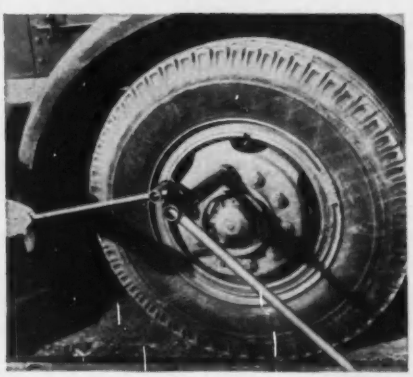
Shelby and Sweeney tame a tough nut

• The Sweeney POWERENCH is a rugged nut turning tool specifically designed with geared action for tightening or loosening the nuts on dual wheels, aircraft propeller shafts, diesel engine cylinder heads, railroad locomotives, and for countless other heavy-duty applications.

Super tough equipment calls for super strong materials. That's why Shelby Seamless Mechanical Tubing—in sizes from 1⅛ in. O.D. to 5⅝ in. O.D.—is used in the manufacture of POWERENCH assemblies. The great strength, complete uniformity, and extreme dimensional accuracy of Shelby Seamless make it the ideal mechanical tubing for the fabrication of such heavy-duty materials. Moreover, it is safe and workable—possessing excellent machining and superior welding properties.

Produced to exacting standards by the world's largest manufacturer of tubular steel products, Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. Call on our engineers for recommendations. They will be glad to make a study of your particular requirements and help you apply Shelby Seamless to your specifications.

NATIONAL TUBE DIVISION
UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

USS SHELBY SEAMLESS MECHANICAL TUBING

USS

4-1226

UNITED STATES STEEL

The Most Critical Parts in STANAT ROLLING MILLS--

--equipped with ORANGE *Cage Type* NEEDLE BEARINGS

"Roll Necks maintain precision under heavy load - - never give trouble"

—reports Stanat Manufacturing Co., Long Island City, N. Y., after five years' experience with Orange Cage Type Needle Bearings in their strip and bar rolling mills and wire flattening mills, used in both the ferrous and non-ferrous metal-working industries. Eight Orange Bearings are used as back-up roll bearings in the roll necks of the Stanat 2-high/4-high Combination Mill shown.

Note that square-end rollers are held in alignment by pockets of a free-floating, land-riding cage made of anti-friction, non-ferrous metal. This cage merely guides—does not wear on rollers.

ORANGE Cage Design assures alignment of rollers—prevents skewing

By eliminating roller skewing, Orange Cage Type Needle Bearings add many advantages to the high load capacity and space savings of conventional needle bearings. For example:

Orange Cage Type Needle Bearings are true running in any position—on horizontal, vertical, tilted or overhung mountings. They are less affected by misaligned mountings or uneven loading. Internal clearances can be accurately controlled. They provide extremely smooth, quiet, trouble-free operation.

Stock sizes from ½" to 8" shaft dia., interchangeable with all standard heavy-duty needle bearings. Stocks and engineering service in all industrial areas.

Send for Engineering Data Book

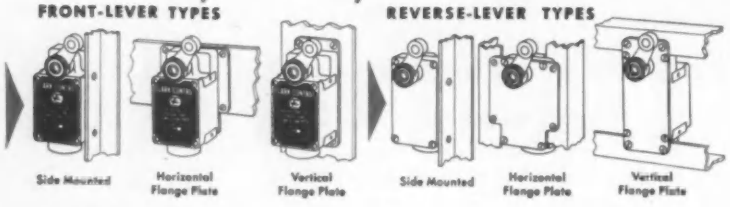
ORANGE ROLLER BEARING CO., INC., 551 Main Street, Orange, N. J.

NEW!

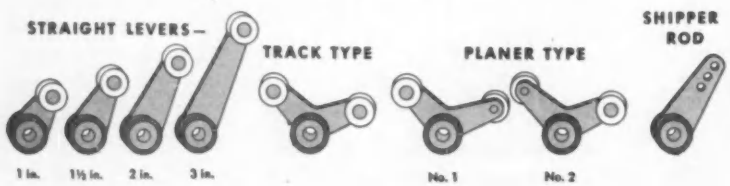
CLARK *Type DM* MACHINE LIMIT SWITCH

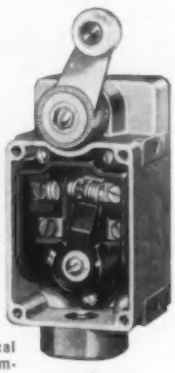
• This new heavy-duty limit switch is built with a minimum of moving parts, and with emphasis on simplicity of construction. The primary objective in its design is to provide dependable, accurate, trouble-free operation for a long life. All latch and trip-bearing surfaces are nylon to steel for minimum wear. All springs are in compression for greatest safety—they cannot be overloaded. This and other features make the switch as nearly fail-safe as possible.

Mounting Arrangements



Operating Levers





Nylon roller cushions impact, has low friction coefficient and long wearing qualities.

Reversible operating lever. Simple screw driver adjustment for reversing or positioning.

Heavy molded insulating chamber surrounds all live parts and provides ample wiring space for four No. 12 wires with Stakon connectors.

Areas subjected to arcing are protected by glass-melamine plates.

Electrical and mechanical sides of switch are completely isolated.

Nema Type 5 dust-tight, oil-tight enclosure of heavy die-cast construction.

Double-concentric overtravel springs in compression for fail-safe operation.

Return spring is in compression. Can be changed without tools to either side of arm, or removed for maintained contact.

Spring-loaded latches are nylon for low friction and long life.

Choice of ½" or ¾" conduit opening.

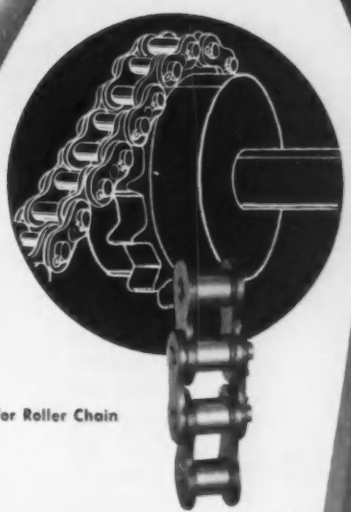
Write for Bulletin 102DM

The **CLARK** **CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

Pressure Cartridge in a Fire Extinguisher



Rollers for Roller Chain

would you recognize these as tubes?

***a better product at less cost can be yours when you recognize the advantages of using* GLOBE steel tubes!**

TODAY, with cost conscious buyers demanding more for their money, it's your responsibility to develop new and better manufacturing methods. There may be parts of your equipment now forged, cast or machined which can be made better from Globe tubing. Result . . . elimination of costly machining operations, and a part that is made better, faster, and at lower cost.

Why not investigate the possible use of Globe tubing in your product? Globe's "one-source" supply offers seamless carbon, alloy, and stainless tubing in a complete range of sizes and analyses. Globe metallurgists and engineers are available to assist in the proper selection of tubing for your particular job. Write for the Globe General Catalog.

Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes —Globeiron (high-purity ingot iron) seamless tubes — Globe Welding Fittings

GLOBE

STEEL TUBES CO.

Milwaukee 46, Wisconsin

Chicago • Cleveland • Denver
Detroit • Houston • Los Angeles
New York • Philadelphia
San Francisco
St. Louis

Keyed...to your cost problems

One key that solves production and cost problems...that improves plant efficiency...is a fresh viewpoint, a new idea.

There's where the specialized services of your Chain Belt Field Sales Engineer can help you. His broad application knowledge...his familiarity with your problems...and the efficient performance of Chain Belt Products can help you find the right key to your problems.

for example: A lift truck manufacturer was seeking a way to reduce over-all costs. His CHAIN Belt Man suggested a change from standard roller chain to leaf chain. Result: lower cost and actually improved performance...far greater strength and life.

for example: A manufacturer of construction equipment was having field complaints about chain failure...with resultant excessive factory replacement costs. His CHAIN Belt Man suggested a change that solved the problem ...improved over-all performance.

for example: A conveyor manufacturer was trying to cut costs to achieve a more competitive price. His CHAIN Belt Man suggested a change from special roller chain attachment links to standard... reducing costs...with no loss of efficiency or life.

Often your CHAIN Belt Man can provide the "key" to your problems. Because he can offer all the advantages of a complete line of drive and conveyor chains, sprockets, attachments, roller bearings and couplings, he can recommend, without prejudice, the exact size and type that will help you cut costs. See him, or write Chain Belt Company, 4715 W. Greenfield Ave., Milwaukee 1, Wis.

CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

Peek under this gleaming chromium plate

and see functional, durable, BRASS at work

In adding a combination steam-and-dry iron to its list of electrical appliances, The Dominion Electric Corp., Mansfield, Ohio, set its goals high. The iron had to be engineered, styled and priced so as to be readily salable in a highly competitive market.

1 Costs *must* be kept down – without sacrificing quality.

2 The iron *must* be light in weight (actually 3¼ lb.) and provide a long service life.

3 It *must* operate unfailingly – anywhere – on ordinary, undistilled tap water.

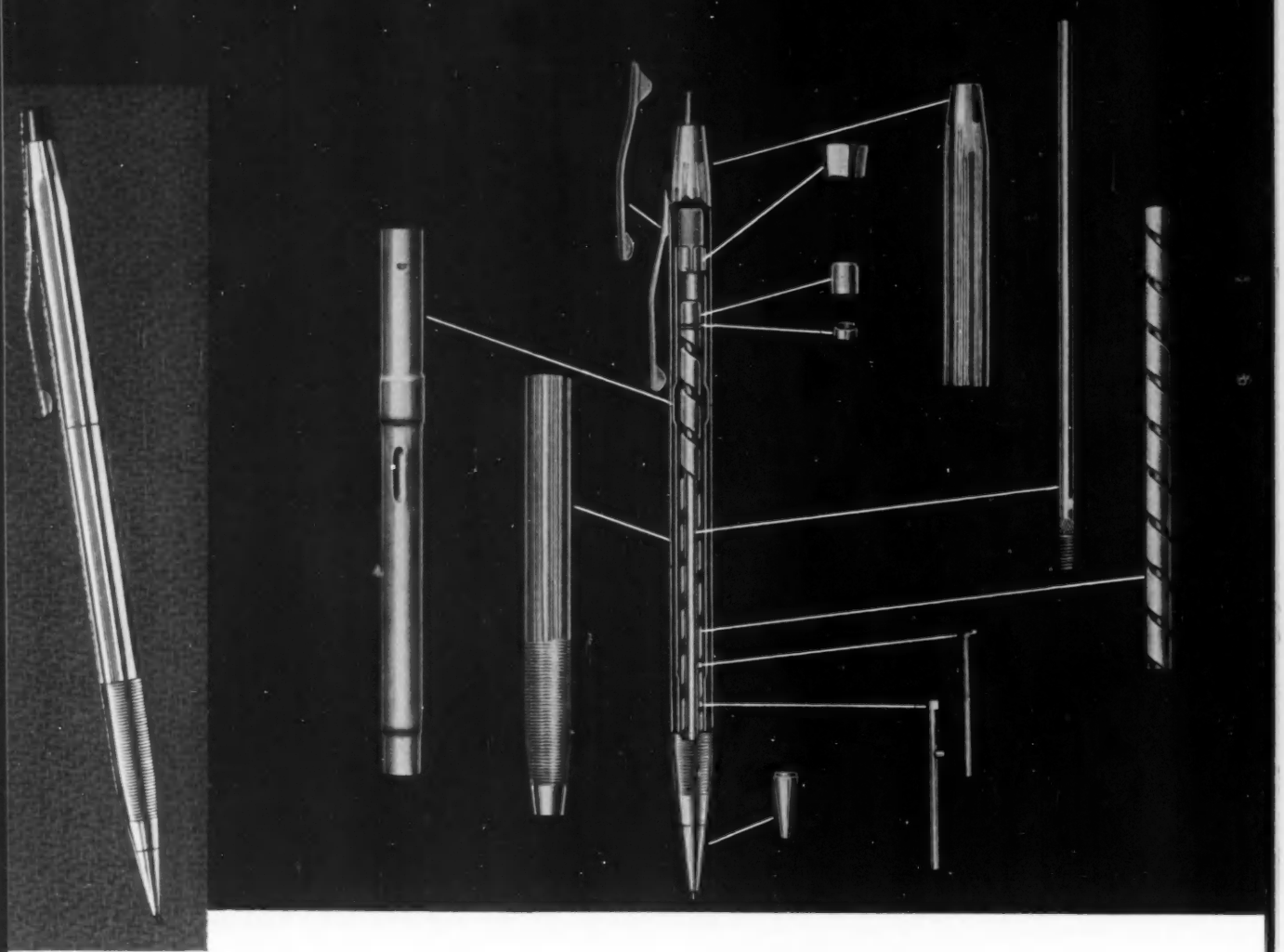
For the housing, steam generator, filler tube and miscellaneous supporting members, BRASS was the answer – as it so often is where freedom from rust, resistance to corrosion, workability and ease-of-finishing must be coupled with moderate cost.

We are glad to report that Dominion's choice and extensive use of Anaconda Brass paid off handsomely; also that we were able to give their engineering and production staffs an assist in selecting the right compositions and the most economical gages and tempers. Perhaps we can do the same for you? Simply write The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5469

ANACONDA

the name to remember in

COPPER • BRASS • BRONZE



CROSS put an end to automatic pencil troubles **with BRASS**

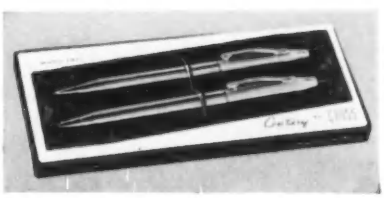
Since 'way back in 1846, America's oldest manufacturer of fine writing instruments—the A. T. Cross Pencil Company, Providence, R. I.—found out that you can do things with brass that you can't do with any other metal. And they've been doing it ever since.

Illustrated above in actual size are an even dozen parts that make up the chromium plated Cross Pencil. All, except the spring clip of phosphor bronze, are made of brass supplied as sheet, strip, wire, rod or tube.

Note the multiplicity of fabricating operations—from the free cutting brass point to the strip-wound spiral—and you'll come to the conclusion that brass gives you the most "easy workability" for your money.

And the man who owns a Cross Pencil—or Pen—is far less apt to fume or fuss. He's got a writing instrument that's tops in quality at a moderate price, with parts that resist wear and corrosion . . . that won't rust, gall or "freeze."

Dependable brass is plentiful—and unrestricted. The days of substitutes are over. Next time the man at the drawing board looks up and says "What'll it be," say "Make it brass." Better yet, say "Anaconda Brass." The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

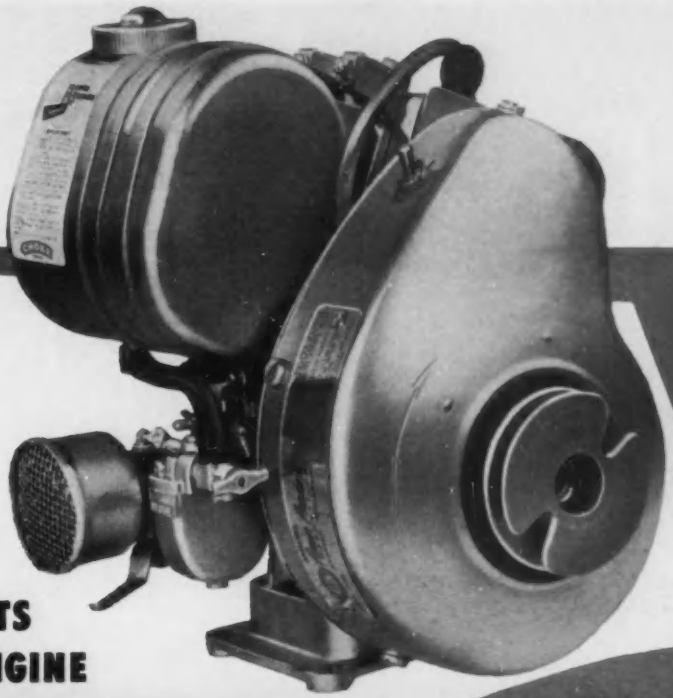


In the exploded view, above, is featured the pencil of the A. T. Cross Chromium Plated Pen and Pencil Set. All parts, including those in the pen, are made of Anaconda Alloys supplied by The American Brass Company since 1913. Cross also uses the same "inside working parts" in two "Century" Pen and Pencil Sets in which the caps, barrels and clips are available in either sterling silver or 1/20 12K gold-filled (illustrated above).

ANACONDA

the name to remember in

COPPER • BRASS • BRONZE



guess

THE WEIGHT of this NEW 2HP POWER PRODUCTS INDUSTRIAL ENGINE

then read how SKF helps make it less than you think!

Here's Power Products Corporation's popular 2-cycle engine that delivers 2 horsepower.

How much would you guess it weighs? Fifty pounds? Thirty? Twenty? Guess any of these and you'd be wrong. It weighs just sixteen pounds.

This remarkable power to weight ratio is made possible, in a large measure, through the use of ball bearings at both ends of the crankshaft. Power Products engineers, like many others, recognized the inherent advantages of the 2-cycle principle—lightweight and compactness. The use of ball bearings on the crankshaft enabled them to virtually eliminate radial play with its related problems previously found in 2-cycle engines and produce a dependable small 2-cycle industrial engine.

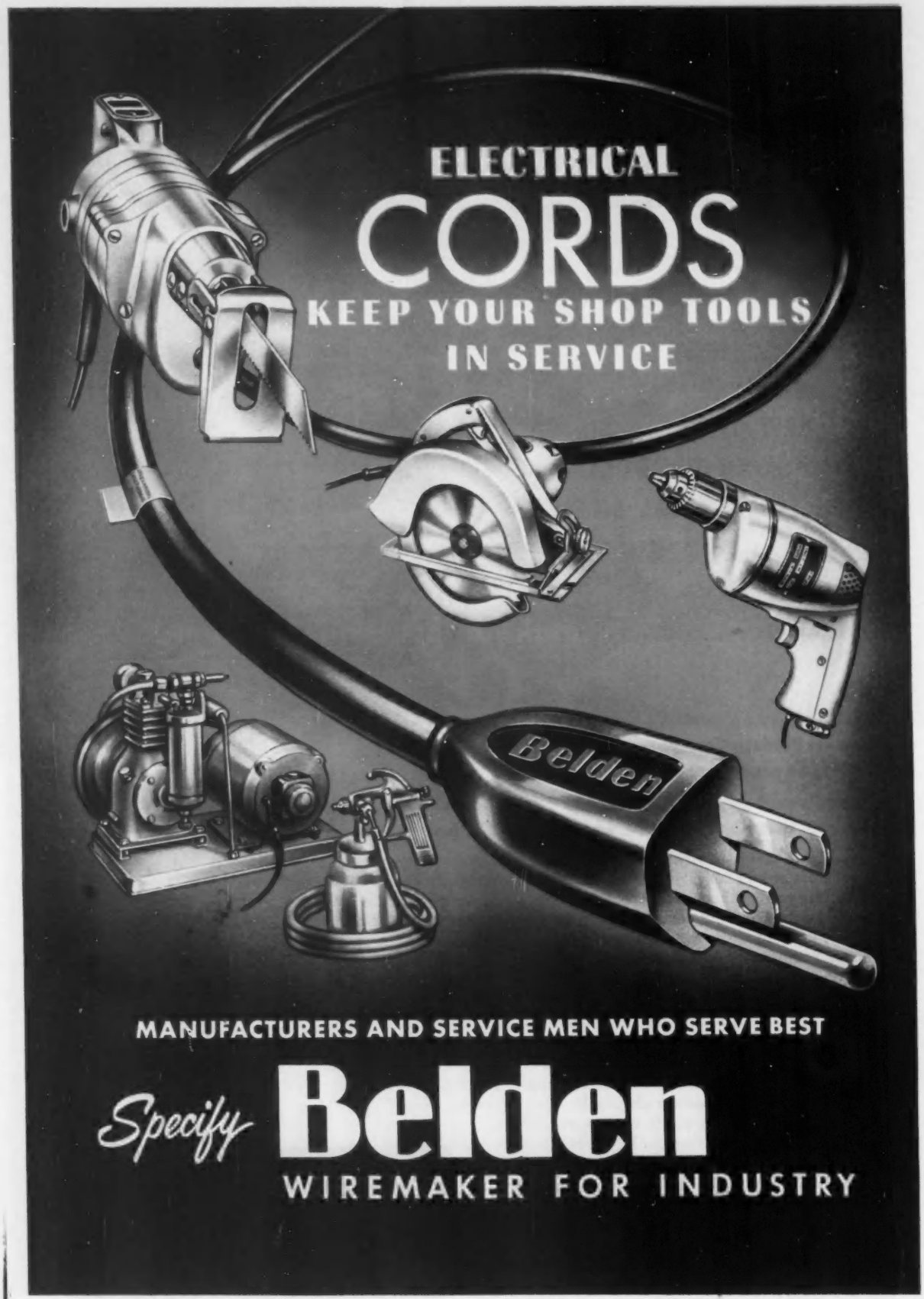
The application of SKF bearings to this and other Power Products 2-cycle engines helps give the engines longer life, easier starting, consistent operation, as well as accurate timing, hotter spark and less friction which means more power.

SKF Field and Home Office Engineers know a lot of places where anti-friction bearings should be used to make your product better—places where their application produces benefits as it does for Power Products. Any of them, without obligation, will analyze the design of your product and perhaps show you how to make it better.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA., *manufacturers of* SKF *and* HESS-BRIGHT® *bearings.*

SKF®

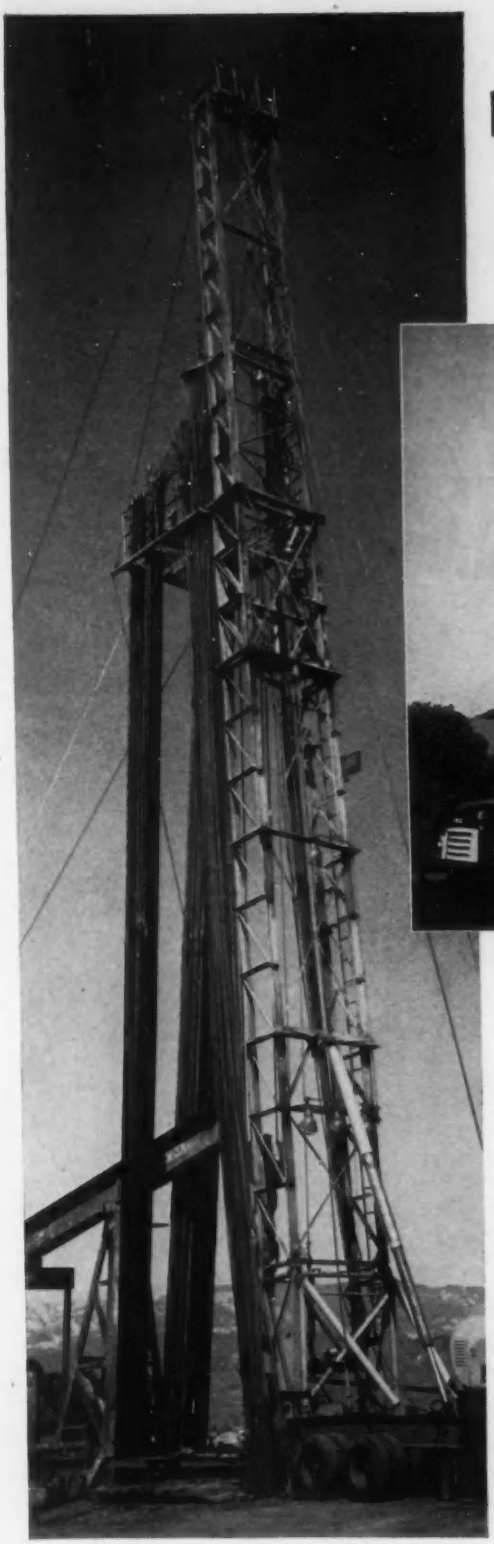
BALL AND ROLLER BEARINGS


ELECTRICAL
CORDS
KEEP YOUR SHOP TOOLS
IN SERVICE
Belden
MANUFACTURERS AND SERVICE MEN WHO SERVE BEST
Specify Belden
WIREMAKER FOR INDUSTRY

Lightweight Mast

DOES A HEAVYWEIGHT JOB

On road, mast built of Mayari R telescopes in half, lowers into horizontal position on trailer much like extension ladder on fire truck.



In operation, mast is 90 ft high. All-Mayari R construction gives it hook-load capacity of 210,000 lb.

The mast for this portable oil-well-servicing rig has to be strong. Pulling up a 10,000-foot string of tubing from an oil well is no job for a weakling, especially if the load is 100,000 lb or more. On top of that, when it breaks loose from the bottom of the hole, the tubing lets go with a rush that bounces the mast like a boy on a pogo stick.

This mast has to be light, too, because it's a portable mast. A trailer carries it from job to job over public highways subject to weight restrictions.

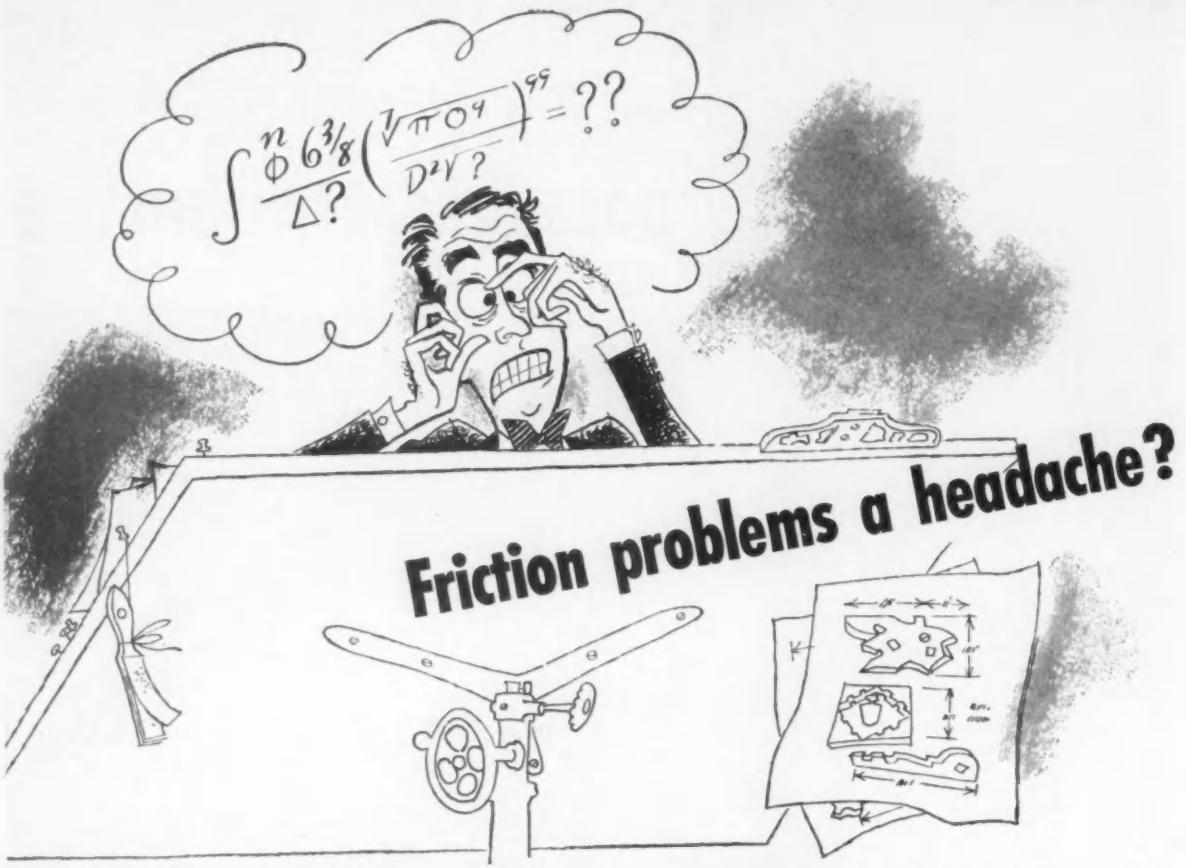
Striking this balance between rugged strength and light weight was a made-to-order assignment for Mayari R low-alloy, high-strength steel. With 50 pct greater strength than carbon steel, Mayari R in lighter sections provided the 100-ton load capacity desired, while paring 20 pct deadweight from the mast. One more in the almost limitless variety of applications in which "Mayari R makes it lighter . . . stronger . . . longer-lasting."

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Mayari R *makes it lighter... stronger... longer lasting*



Friction problems a headache?

Let your J-M Friction Specialist help find a cure

If your organization is having friction material problems, a phone call or letter from you will enlist the help of a Johns-Manville specialist.

His expert knowledge and wide practical experience will help you quickly select the right friction materials you need, no matter what the job.

How can Johns-Manville give you this "Johnny-on-the-spot" service? Three short sentences tell the story:

1. **We are pioneers** in the manufacture of friction materials for every type of equipment.
2. **We have built** up a storehouse of "know-how" by our contacts in supplying these materials to practically every type of industry.
3. **We maintain** one of the most extensively equipped laboratories in the world for the development of friction materials.

So regardless of your problem, don't lose time. Instead, phone or write your nearest Johns-Manville office—or Johns-Manville, Box 290, New York 16, N. Y.—and a J-M friction specialist will be on his way to help solve it in a hurry.

Here's your guide to the right friction material for the job—

Even if you do not have an immediate friction material problem you may have use for a reference source. Booklet FM-12A (right) is yours for the asking. It contains complete descriptions, specifications, and a handy selector chart. For your copy write Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *Asbestos* FRICTION MATERIALS

It bested the bush country in
BORNEO
BROOK MOTORS
are built to beat your climatic conditions, too!
When the going is *really* rough and there's the nastiest kind of weather to contend with, you can't call on just any electric motor to do the job. It has to be a motor *built* to operate successfully under the most severe conditions, anywhere in the world, outdoors or indoors . . . it has to be a Brook motor—for over fifty years, the world's most respected motor.
Weatherproofing is a part of Brook's *standard* manufacturing operation. Stator slots and windings of *every* Brook motor are impregnated and baked to resist moisture, dust, heat and cold. Every Brook motor is precision built to meet or surpass NEMA standards. They use standard bearings, threads, and nuts. All major types are available from stock, in a wide range of horsepower sizes. World-wide service stations have a complete selection of parts . . . Brook motors are easily serviced in *any* shop, anywhere. Be sure to specify Brook by name . . . the world's *most respected* motor—built by the world's *most experienced* manufacturer. Write for free illustrated catalog today!
FAST DELIVERY OF ALL POPULAR MODELS!
Brook motors are available from warehouses at Chicago, Jacksonville, Hawthorne, N. J., Houston, Los Angeles, San Francisco, Seattle, and other major distributing points.
Splashproof flange mounting
world's most respected motor
BROOK MOTOR CORPORATION
Totally enclosed externally fan-cooled
Single-phase
Totally enclosed non-ventilated
Open drip-proof
1904-1954
...respected and used the world over for 50 years!
BROOK MOTOR CORPORATION
3555 W. Peterson Ave., Chicago 45, Illinois

Type 316

No. 7-Mo

How Can Corrosion Control Service Like This Pay Off For You ?

No doubt about it . . . your corrosion problems are different. In working with plant after plant we know this is true. We also know that one of the phenomena of corrosion resisting steels is that there doesn't seem to be a cure-all. This is exactly why we have equipped ourselves, through constant laboratory research and field work, to render a truly helpful corrosion control service for plants like yours. This service includes development of totally new steels such as Carpenter No. 20, a super corrosion resisting stainless that comes closest to providing the answer to economical handling of a wide range of chemicals, including hot sulphuric acid.

What's *your* corrosion problem? Perhaps Carpenter's Corrosion Control Service, backed by experienced metallurgists, can help solve it. Take time now to drop us a line on your company letterhead. At no obligation, we'll be glad to work with you. THE CARPENTER STEEL COMPANY, 117 W. Bern St., Reading, Pa.

SOLVED :

A Tough Problem in Handling NITRIC-HYDROFLUORIC ACID

Problem :

An eastern plant was using Stainless Type 316 for baskets, racks, etc., in a pickling process involving a solution of nitric-hydrofluoric acid. The concern was running up against costly problems caused by fast deterioration of the equipment. Then they threw the problem in Carpenter's lap. We worked closely with them right from the start . . . supplied test samples of several Carpenter Stainless grades.

These were inserted in the solution (17% nitric acid, 6½% hydrofluoric acid) under actual operating conditions. Part of each specimen was held in the quiescent portion of the solution . . . and part of each was exposed to the aerated condition. They were exposed continuously, to the same medium encountered in normal operation, for a period of 117 days.

Statistics :

Agitation: None *Temperature:* 70 to 130°F
Contaminants in Bath: chromium, iron, nickel salts, along with a sludge of metallic oxides

Of the samples tested, Carpenter No. 7-Mo provided the best results. For example, here are results in loss of metal comparing Stainless Type 316 with No. 7-Mo:

Loss of metal, in inches per month:

No. 7-Mo	.0009 ipm
Type 316	.0074 ipm

These results indicated to the concern that baskets and racks made from Carpenter No. 7-Mo will last *eight times longer* than those made from Type 316.

Carpenter STEEL

Super Corrosion-Resistant Stainless

Pioneering in Improved Tool, Alloy and Stainless Steels Through Continuing Research

Export Department: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

the amazing "lubrication fitting" that thinks ahead...

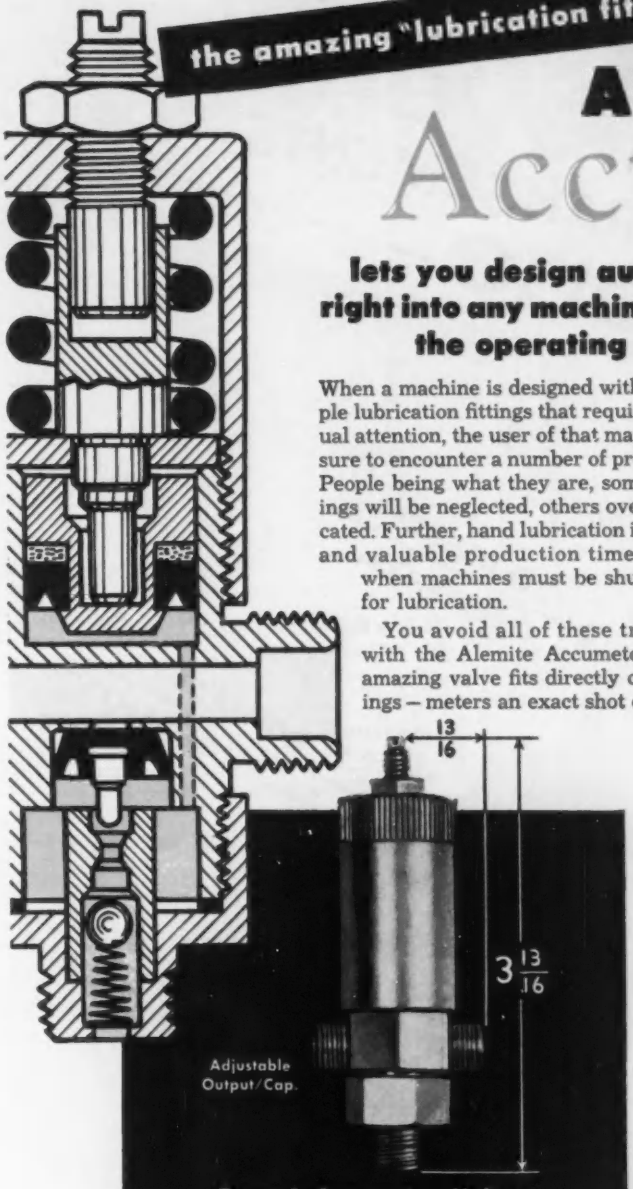
ALEMITE Accumeter®

lets you design automatic, fool-proof lubrication right into any machine—simply, economically...offers the operating savings industry will buy!

When a machine is designed with multiple lubrication fittings that require manual attention, the user of that machine is sure to encounter a number of problems. People being what they are, some bearings will be neglected, others over-lubricated. Further, hand lubrication is costly and valuable production time is lost when machines must be shut down for lubrication.

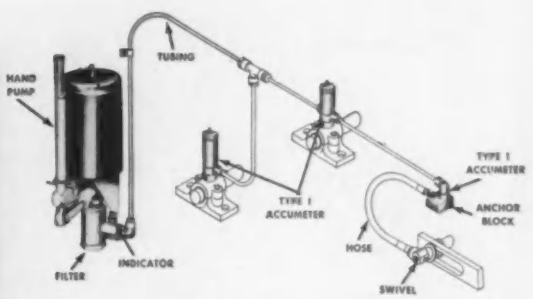
You avoid all of these troubles with the Alemite Accumeter. This amazing valve fits directly on bearings – meters an exact shot of oil or grease *automatically—at pre-determined intervals—while the machine is in operation!* Time, production and maintenance costs are cut to the bone! With all these advantages, it is small wonder that 95% of all major plants buying machine tools specify centralized lubrication.

The Alemite Accumeter system is simple to design and build into any machine. Automatic Accumeter Systems assure you positive, low-cost lubrication. Find out about these automatic systems now. See the savings, the efficiency they add and you too will specify Accumeter!



Type 1 Accumeter Valves

For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Spring pressure provides gradual feed. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.



offers all these advantages!

- Eliminates shutdown time for lubrication. Adds productive time to machine output
- Seals completely against dirt, grit, water all the way from "Barrel-to-bearing"
- Prevents bearing troubles due to neglect or use of wrong lubricant
- Services all bearings—including those inaccessible or dangerous—in one operation
- Avoids work spoilage and bearing repairs due to over-lubrication

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—*equal to* 122 YEARS *of twice-a-day service!*

ALEMITE

REG. U. S. PAT. OFF.

A PRODUCT OF SW STEWART WARNER

Free --*Alemite Accumeter Catalogue and Engineering Data Book.*

ALEMITE, DEPT. T-124
1850 Diversey Parkway, Chicago 14, Illinois

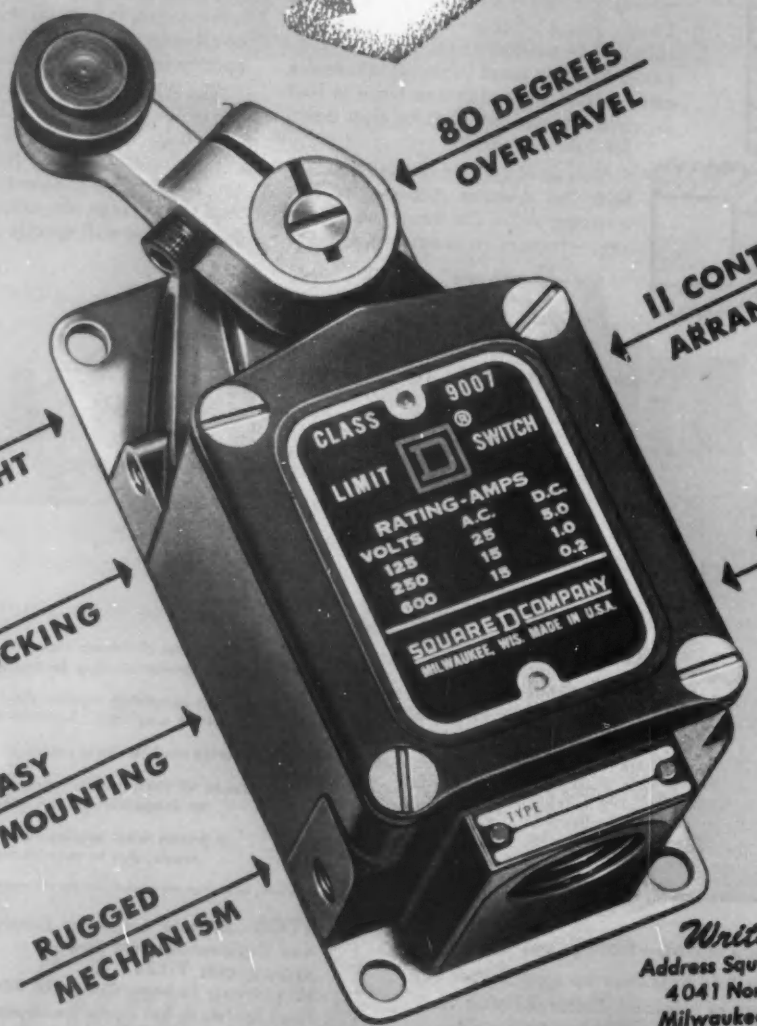
Please send me my free copy of the Alemite Accumeter Catalogue and Engineering Data Book.

Name_____

Company_____

City_____ State_____

YOU GET eleven CONTACT ARRANGEMENTS IN one



80 DEGREES OVERTRAVEL

11 CONTACT ARRANGEMENTS

SIMPLE ADJUSTMENT

OIL TIGHT

EASY STOCKING

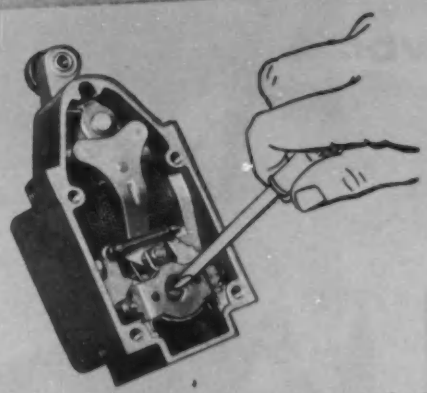
EASY MOUNTING

RUGGED MECHANISM

Write for Bulletin SM-239
Address Square D Company,
4041 North Richards Street,
Milwaukee 12, Wisconsin

SQUARE D COMPANY

WITH THIS NEW MACHINE TOOL
LIMIT SWITCH!



Versatility Plus! Simple adjustment of return spring positioning plate determines position of the movable contact in the "free" position. Equally simple adjustment of latches makes switch either single acting, or double acting with neutral position...

11 switches in 1... all you need is a screw driver!

Adjustable! Operating lever arm position is continuously adjustable and provides up to 80° overtravel unless limited by enclosure. An outstanding Square D design feature.

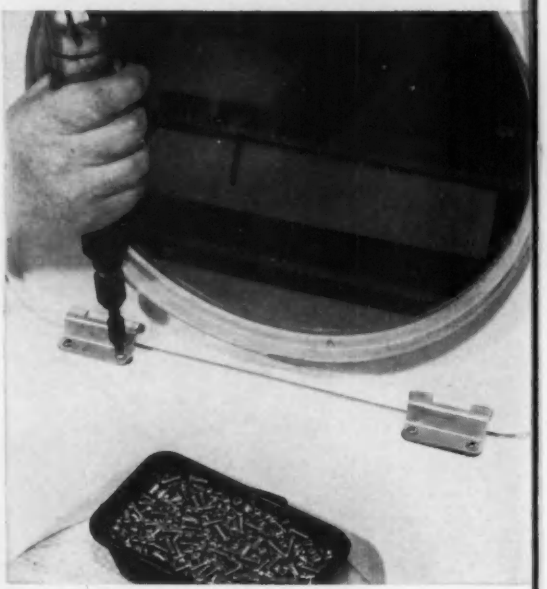
No Inventory Problem! Square D's basic switches and lever arms are separately packaged for your stocking convenience. A moderate stock covers a multitude of possible combinations.

Easy Mounting! Square D provides seven different base plates, plus side mounting holes. It's easy to mount switches in a variety of positions.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

Users praise Phillips Cross-Recessed-Head Screws

DOMINION ELECTRIC COFFEE MAKERS count on the neat appearance and easy installation of Phillips screws. "These screws give us product features we can't get using other screws," states W. A. Reis, Product Engineer. Note, above, that the lower screw that fastens the handle is in a "blind" position and only a little distance from the bottom of the coffee maker. An ordinary one-slot screw would be too difficult to drive on a production line. A part of the coffee maker itself would have to be re-designed.



RUST IS ELIMINATED ON APEX AUTOMATIC WASHER because water can't get under tight bond of Phillips screw heads. Their safety feature is also important. "First," says William A. Haverlock, superintendent of assembly, "it eliminates danger of both worker and customer cutting hands on burrs and sharp edges caused by driver slippage. And, second, it reduces chance of direct injury to assembly personnel from driver." Door hinge, above, is fastened with Phillips screws.

SINGER VACUUM CLEANERS, manufactured at the Finderne, N. J., Plant of The Singer Manufacturing Company's electrical division, use Phillips screws in many applications. "These screws help us maintain a peak schedule," states Francis A. Gall, Vacuum Cleaner Engineer, "they greatly enhance the beauty of our design, eliminate possible damage to exterior finish and provide a means for driving screws into hard-to-get-at places." Gerald Turley here makes difficult angle installations of a Phillips screw in motor.

• MANUFACTURERS OF • PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY

...AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Elco Tool and Screw Corporation • Great Lakes Screw Corporation • The H. M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.

Take this common sense approach to PUMPS

Save Time, Money, Trouble

Get specific engineering help

You'll find it pays off in hard cash to standardize on reliable, low maintenance Allis-Chalmers pumps for all your needs. That's because your A-C representative is an experienced, highly qualified engineer who will give you full cooperation at every step of the way—from planning to purchasing to production. Being a specialist in individual pump applications, as well as OEM design and production problems, he can frequently make valuable suggestions which result in substantial savings in time, money and effort — improved performance of your product.

ALLIS-CHALMERS
Centrifugal
PUMPS

Get immediate delivery from stock

A-C centrifugal pumps — in a broad range of types and sizes—are carried in stock by warehouses all over the country. Your A-C representative will show you how to expedite pump selection and ordering . . . make sure you get the exact units you require for maximum performance at lowest cost. Find out for yourself why more and more OEM's are standardizing on Allis-Chalmers Pumps. Get all the facts from your Allis-Chalmers district office.

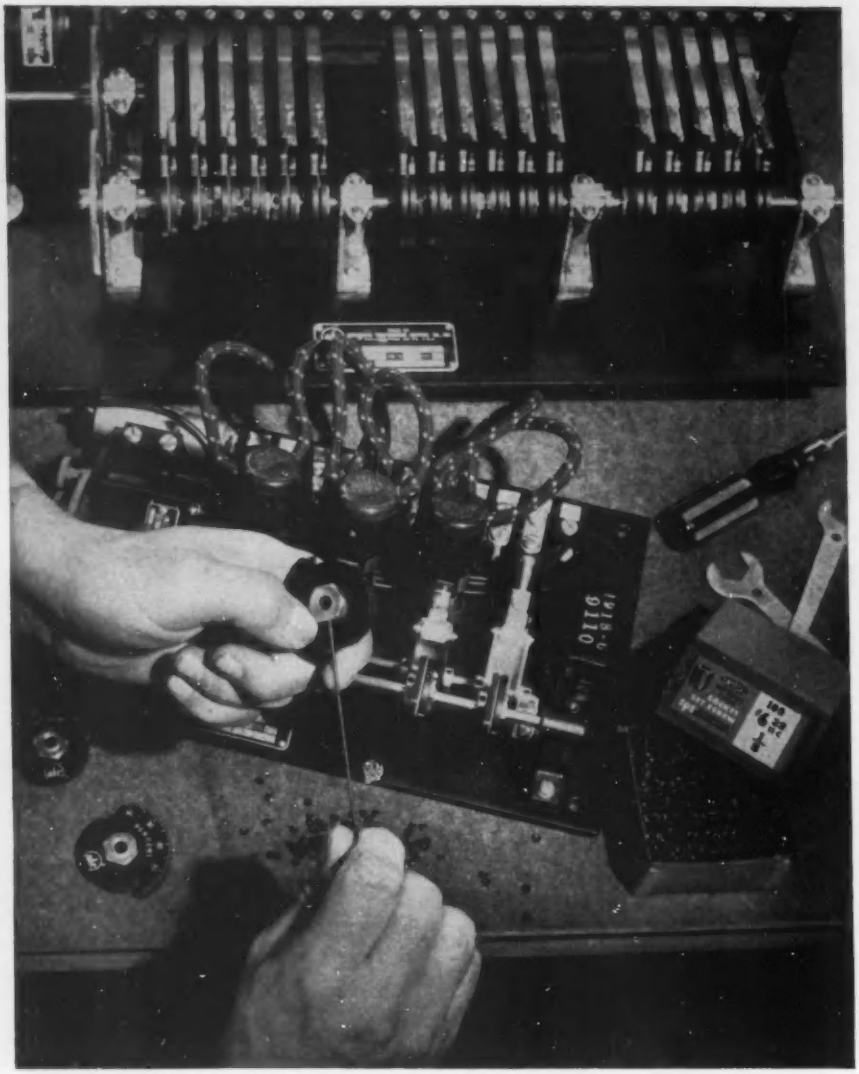
A-4493

Electrifugal is an Allis-Chalmers trademark.

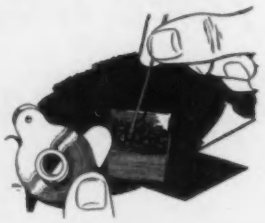
For literature on Allis-Chalmers
FHP Package Pumps get Bulletin 52B7529 . . . *Electrifugal* Pumps, Bulletin 52B6140 . . . Supporting Adaptor Pumps, Bulletin 52B6083 . . . Vertical Mounted Pumps, Bulletin 52B6975. Write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS



Two UNBRAKO Self-Locking Socket Set Screws are used on each cam of these precision multicircuit cam timers. The screws position the cams so as to control accurately the sequence and duration of one or a series of individually timed machine or process operations.



Assembler picks up tiny UNBRAKO set screw with long arm key preparatory to threading it into cam assembly.

He inserts the UNBRAKO, and turns it into the assembly; then after positioning cam, tightens it. The accurate depth and size of the hex socket result in maximum torquing—the knurled cup point holds the cam accurately in place.

UNBRAKOs—made of heat treated alloy steel—have fully formed threads, Class 3 fit; are supplied in standard sizes from #4 to 1".

You'll need less space for storage when you use UNBRAKO Standards—stocked by your distributor

You'll need less space for storage and be able to carry a smaller inventory, because standard UNBRAKO socket screw products are in stock at your local industrial distributor's. And you'll save time and money, because deliveries are prompt. For more information, write for UNBRAKO Standards—a complete listing of socket screw products made by the world's largest manufacturer of these precision fasteners. STANDARD PRESSED STEEL Co., Jenkintown 28, Pa.

UNBRAKO® SOCKET SCREW DIVISION

SPS JENKINTOWN PENNSYLVANIA

want high speed plus endurance? How's this...

1000 HOURS at 3600 R.P.M. UNDER FULL LOAD!

If you were to drive 90,000 miles up an incline at 90 m.p.h., you would approximate the performance of the Model 24A, 331 cubic inch displacement Chrysler Industrial Engine pictured below.

To prove the power of Chrysler Industrial V8 Engines . . . their ability to run for long periods of time at high speed . . . on March 17, 1954 Chrysler engineers placed a production model Ind. 24A Engine on an endurance dynamometer at Chrysler Central Engineering Laboratories. Objective: 1000 hours operation at 3600 R.P.M. under full load.

During every one of the 1000 hours, the Chrysler Ind. 24A Engine delivered an average of 174 horsepower and when shut down, the engine was still in perfect operating condition.

During the run no service was necessary beyond minor maintenance care, such as oil changes and very infrequent spark plug changes and point adjustment. Yet, following disassembly of the engine, the only wear noted was negligible—no more than you might expect from an engine that has been operated for 1000 hours within a long period of time.

While there is every reason to believe that this is a record-breaking endurance run (and don't forget it was made at 3600 R.P.M. under full load), we are confident that every Chrysler Industrial V8 Engine will *at least equal* this astounding record.

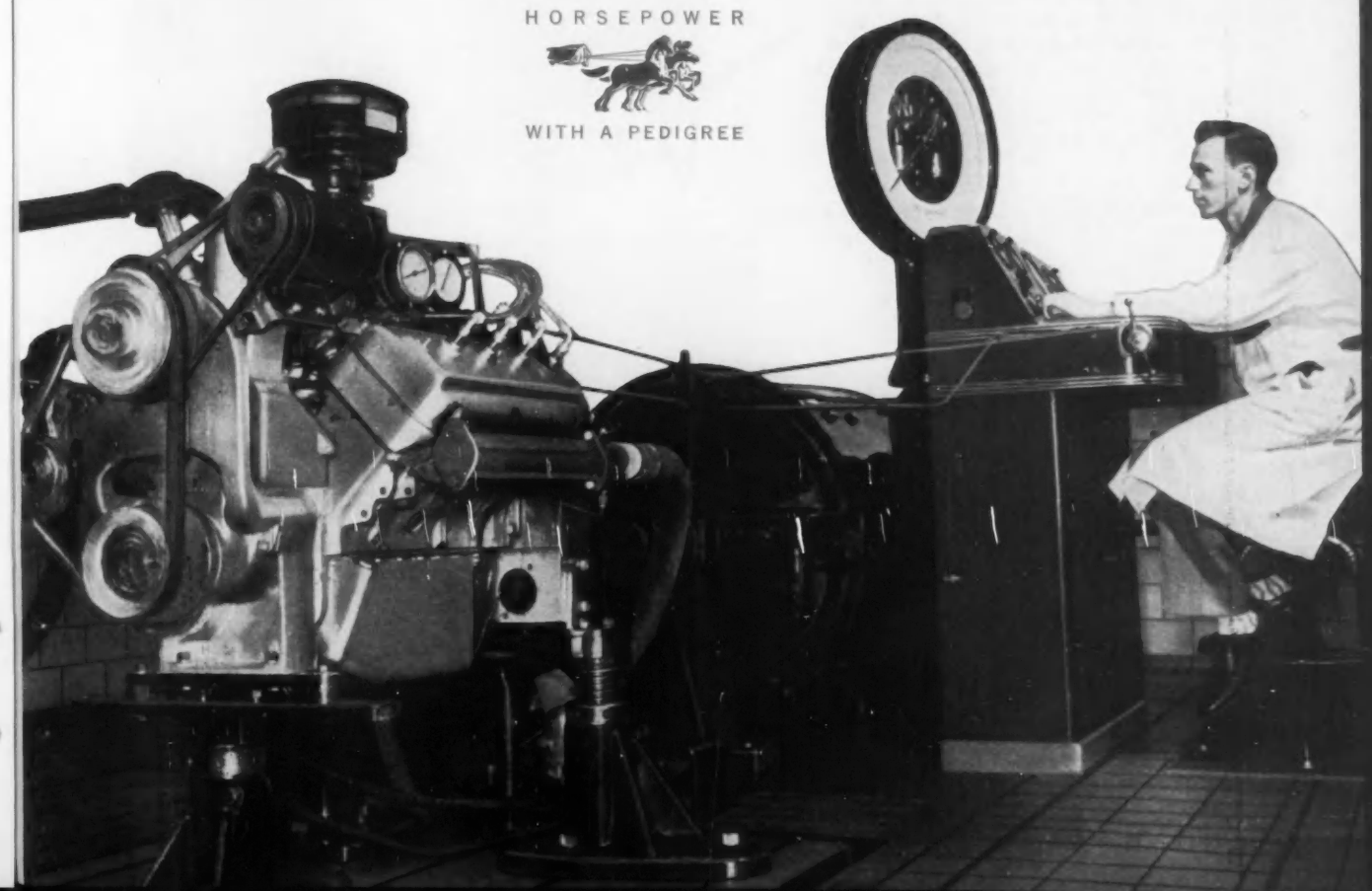
This proves too, beyond a doubt, that the Chrysler Industrial V8 hemispherical combustion chamber design with its short-stroke, low-friction construction, makes an ideal power plant for any equipment that requires continuous high speed operation. Furthermore, in installing a Chrysler V8 Engine in preference to a diesel engine of similar horsepower, you can reduce your size estimate by one-half, your weight by two-thirds, and your cost factor by three-quarters!

For detailed information on the Model 24A or any Chrysler Industrial Engine, see a Chrysler Industrial Engine Dealer, or write: ***Dept. 512, Industrial Engine Division, Chrysler Corporation, Trenton, Michigan.***

CHRYSLER *Industrial Engines*

INDUSTRIAL ENGINE DIVISION • CHRYSLER CORPORATION

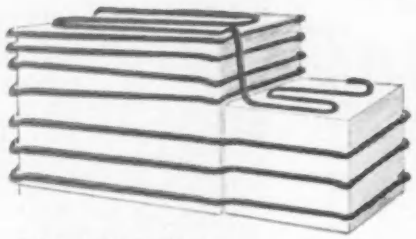
HORSEPOWER WITH A PEDIGREE



FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*

SWEATER DRYING FORM

LEGS FOR MODERN DESK



COILS FOR HOME FREEZER

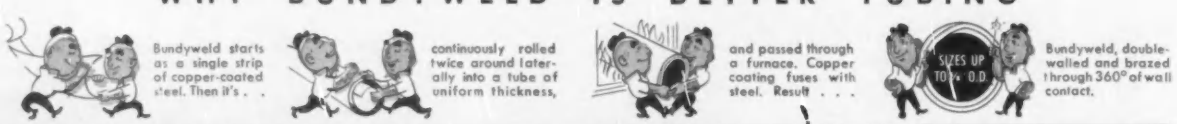
REMARKS Are complicated tubing snarls eating into profits? Why not let skilled Bundy engineers show you how to simplify fabrication operations; save time, money, materials. Why not check, too, the advantages of using strong, lightweight Bundyweld, the only tubing double-walled from a single metal strip.

WRITE today for catalog or for help in developing your tubing application.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN

FRAME FOR TOY WHEELBARROW

WHY BUNDYWELD IS BETTER TUBING



Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

BUNDYWELD TUBING®

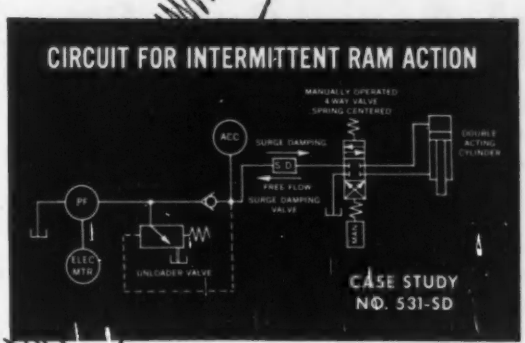
DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Takes plating
Bright and clean
No inside bead
Uniform I.D., O.D.

Bundy Tubing Distributors and Representatives: *Bridgeport, Conn.:* Karhumel Steel & Aluminum Co., 117 E. Washington St. • *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Los Angeles 58, Calif.:* Tubesales, 5400 Alcoa Ave. • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave., South • *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., E.
Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.

Protects hydraulic circuits

ACTUAL SIZE



Denison Surge Damping Valve prevents hydraulic shock... eliminates damage to fittings, lines, seals and equipment

Sudden starting, sudden release of high pressure into a low pressure area, or reversal of flow causes a hydraulic surge as damaging to a circuit as blows from a hammer.

The Denison Surge Damping Valve converts the hydraulic surge into a smooth, gradually accelerated flow of fluid power. A hydraulically unbalanced reaction flow control in the valve causes the valve to open slower as the intensity of the surge increases.

Lightweight and easy to install, the Denison Surge Valve can be used on any circuit up to 5000 psi. Requires no adjustment . . . interferes in no way with the efficiency of the circuit.

The circuit shows a Denison Surge Damping Valve preventing hydraulic shock when stored-up energy in an accumulator is released. For a bulletin on the surge valve, write to: THE DENISON ENGINEERING COMPANY, 1194 Dublin Road, Columbus 16, Ohio.

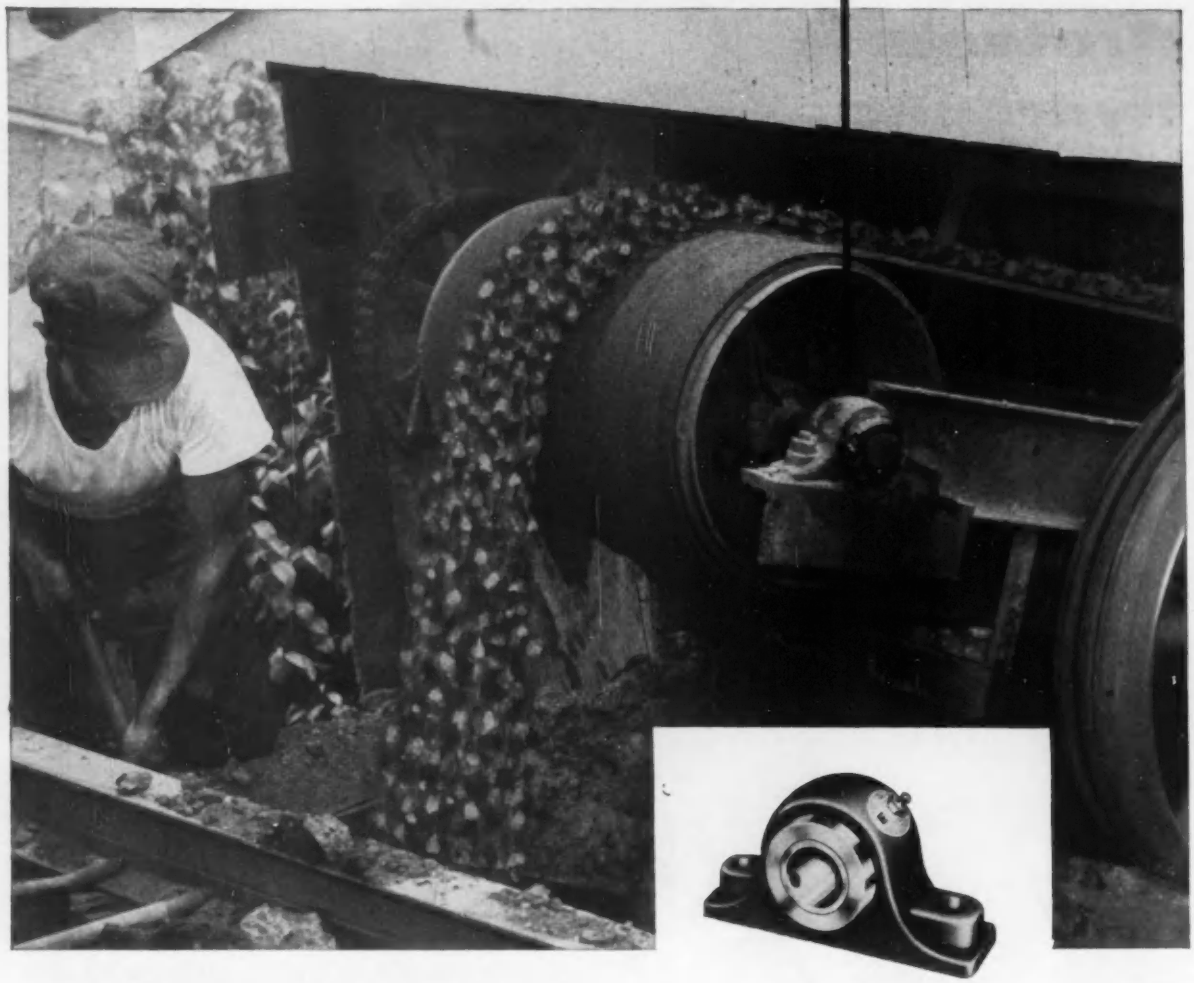
PUMPS • CONTROLS
MOTORS • PRESSES

DENISON
TRADE MARK
Hydr OIL ics

COMPLETELY ASSEMBLED
FACTORY ADJUSTED
PRE-LUBRICATED

SEALED

—ready to mount on the shaft!



DODGE-TIMKEN *America's Quality Pillow Block*

Extra measures are taken to build superior quality into Dodge-Timken Bearings; and extra precautions are taken to keep that quality *intact*—from the factory to distributor to you to your machines.

These bearings are sealed in manufacture—an integral part of Dodge-Timken design. Their inbuilt precision is protected *both on and off the shaft.* That is one reason why they easily deliver a minimum of 30,000 hours of service. Want evidence? Look around you. No other pillow block is so widely used on the nation's tough jobs. Dodge-Timken dependability has been proved in *millions* of installations.

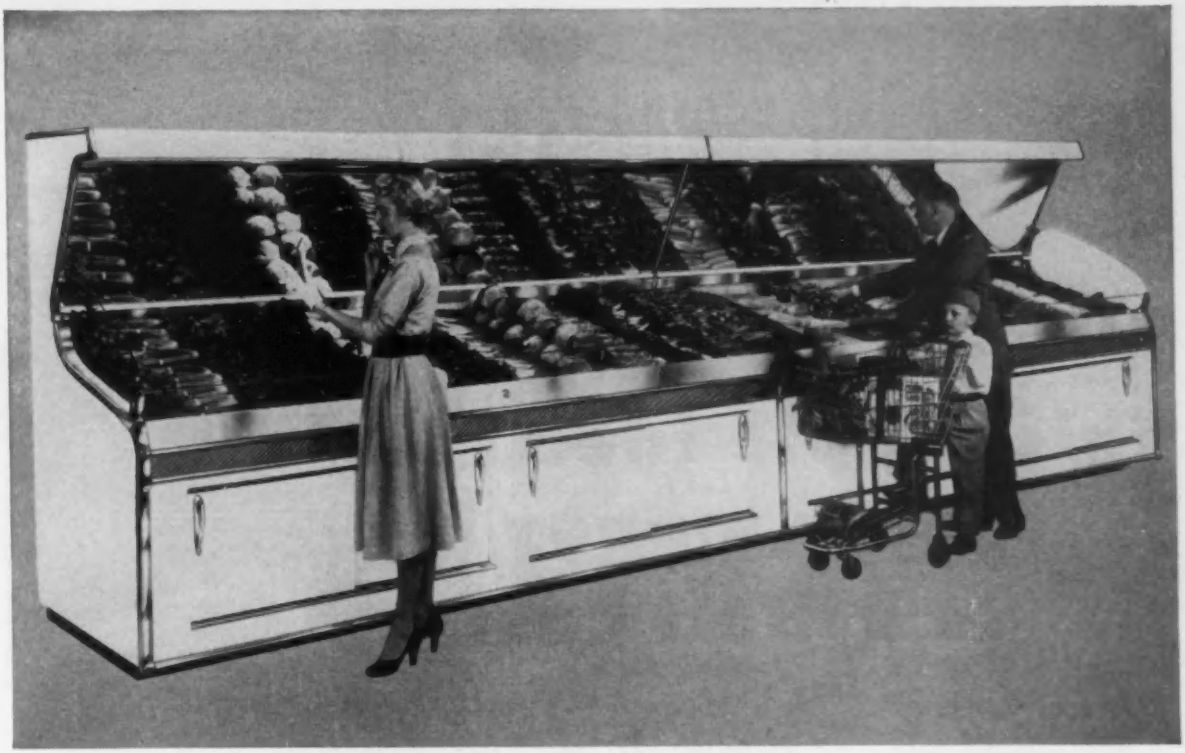
There are 5 types of Dodge-Timken Pillow Blocks for all types of service, in shaft sizes from 1 3/16" to 10". Also Dodge-Timken Hanger Bearings, Flange Bearings, Take-ups.

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.



Here's a trim that trimmed costs

● Lots of people would like to use stainless steel. But they think it's expensive. Here at Republic, we maintain it isn't, when you use it correctly. And here's an example.

Take these commercial refrigeration cabinets. C. V. Hill formerly trimmed them with molding that had to be burnished to get the right finish. Now they use Republic's Enduro Stainless Steel Strip, No. 2 Strip finish. There's no burnishing.

And they save 3 cents a foot.

Looks nicer, too. Lots of eye appeal. And easy to keep attractive because Enduro Stainless Steel can usually be cleaned with a simple soap and water rinse. There's no finish to flake or peel. Nothing to tarnish, because Enduro is stainless steel all the way through.

Republic can show you how to use Enduro Stainless Steel to best advantage. We have facts on how to fabricate it. What type to use. And where. A phone call will bring you in contact with one of our metallurgists. He'll take it from there. Have your secretary phone your nearest Republic District Office.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC
ENDURO STAINLESS STEEL

Other Republic Products include Carbon and Alloy Steels — Titanium — Pipe, Sheets, Strip, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

This simple idea saves money in V-Belt Costs

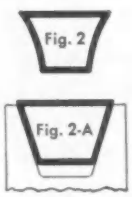
You can prove it in two minutes!

To prove how the CONCAVE SIDES of GATES VULCO ROPES *save money,* just make this simple test—

Bend *any* V-Belt that has *straight sides* (Fig. 1) and—as the belt bends—*feel* the sides *bulge out* (Fig. 1-A). This out-bulge concentrates the wear at the points shown by arrows—and this naturally shortens the life of a *straight-sided* belt!

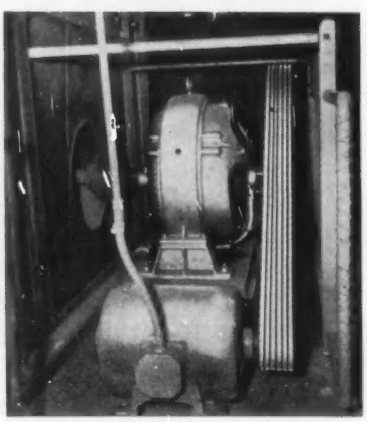
Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U. S. PAT. 1813698)



You find that the CONCAVE SIDES *fill out* and become perfectly straight. They thus press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the GATES VULCO ROPE—and this means *longer* belt *life* and *lower* belt *cost* for you!

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the GATES VULCO ROPE!



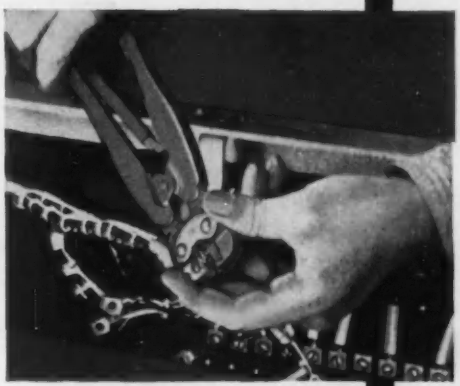
Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

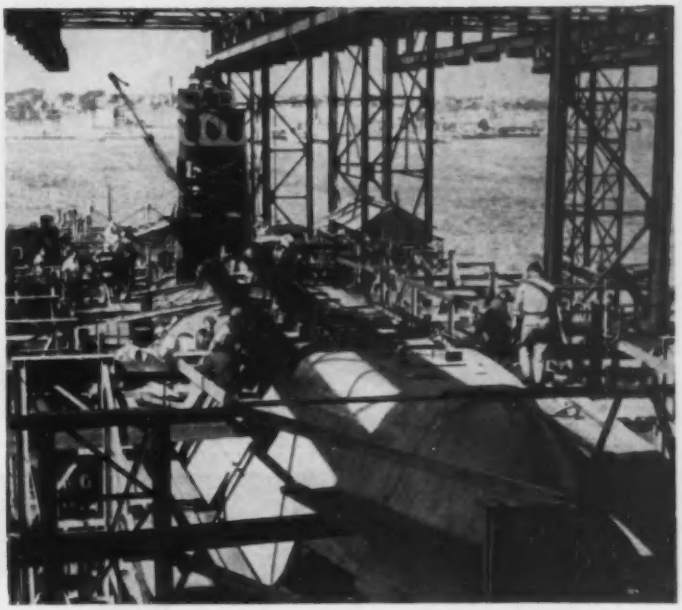
VULCO ROPE DRIVES

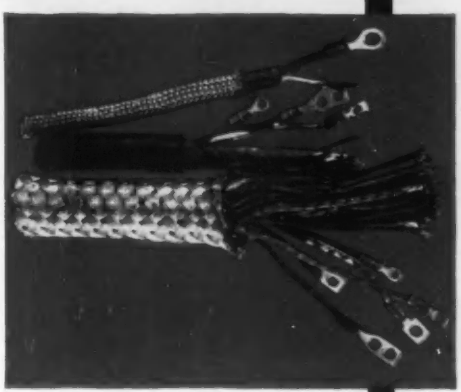
THE GATES RUBBER COMPANY
DENVER, U.S.A.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

CS-545







ATOMIC SUB USES NEW AMP WIRE TERMINATION TECHNIQUE

Typical of the results of AMP's program of research and development are the terminal installations shown above on the Navy's new atomic powered submarine, "Nautilus". In providing a practical method for terminating MSCA cable, AMP engineers have proven many advantages of solderless pressure-type wiring methods heretofore unknown in this field.

Whether it is lower cost, improved quality, or simplified installation methods, the millions of AMP terminals in use today are proving their value in all types of wiring applications. Wherever wire termination problems exist, AMP Field and Service engineers are ready to work right on the spot to add their experience, as well as the entire facilities of AMP's Research and Development Division to help solve the problem. That is why "Wherever There's Electricity You'll Find AMP"

Aircraft-Marine Products, Inc.
2100 Paxton Street, Harrisburg, Pennsylvania

In Canada . . . . Aircraft-Marine Products of Canada, Ltd.
1764 Avenue Road, Toronto 12, Ontario, Canada

Find out about the New AMP "CREATIVE APPROACH TO BETTER WIRING"

... An evaluation survey without cost or obligation.

Need an oil seal that's ideal for FLEXIBLE operation?...

Exhaustive tests by Ajax Flexible Coupling Co. showed that Clipper Seals met all 10 of these exacting requirements

THIS NEW AJAX DIHEDRAL COUPLING handles misalignment, hitherto considered impossible, between driving and driven machines. Because of its unusual design features, it was necessary for Ajax engineers to anticipate and set up rigorous qualifications for the oil seal that would safeguard the lubricants in the coupling. Clipper Seals were selected because they fulfilled *all ten* of the following *requirements:*

1. **A tight fit** on each gear hub, and proper contact with the inside diameter of housing.

2. **The ability** to stand up under constant flexing over a wide range of speeds.

3. **Sliding contact** with hub to allow free end float.

4. **Absolute retention** of lubricant to protect gear teeth.

5. **The dual function** of keeping the dirt out and the fluid grease in.

6. **Long life** to equal the long life of the coupling under severe conditions.

7. **Ability to withstand** normal running as well as increased ambient temperatures encountered in steel mills, foundries and processing plants.

8. **Performance unaffected** by operation in corrosive atmospheres, and by hosing down with water.

9. **A range of sizes** to meet the required sizes of the manufacturer.

10. **Convenience** of assembly and disassembly in the field.

Clipper Seals, day after day, are meeting new and arduous requirements set up by design engineers in almost every field. Their wide variety of compact designs, their precision moulding, and ease of installation have given them a high preference rating for almost any sealing condition on all types of equipment. For further details, address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

Wearplates and Washers

with bearing properties. Bronze wearplates in many sizes and shapes, with precision-machined details . . . holes, slots, grooves, bevels or recesses. Washers of bronze, steel or bimetal combination. We specialize in standard and special bearing parts. Engineering service. Quality control.

FEDERAL-MOGUL CORPORATION • 11043 Shoemaker, DETROIT 13, MICH.

FEDERAL Mogul

FEDERAL-MOGUL

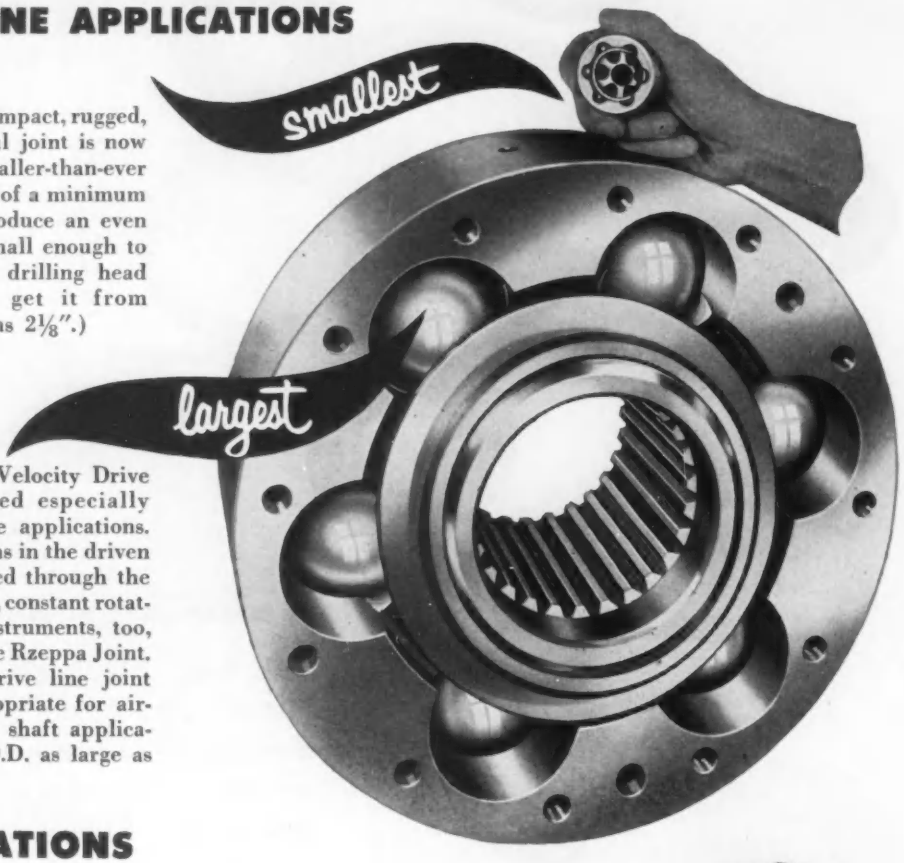
SINCE 1899

Also sleeve bearings in many designs and sizes; cast bronze bushings; bimetal rolled bushings; rolled split bushings; spacer tubes and bronze parts.

What's New in Constant Velocity UNIVERSAL JOINTS

FOR DRIVE LINE APPLICATIONS

Industry's demand for a compact, rugged, constant velocity universal joint is now being serviced with the smaller-than-ever Rzeppa. If you have need of a minimum weight joint that will produce an even flow of power—a joint small enough to be suitable for machine drilling head applications—you can get it from Rzeppa. (O.D. as small as 2⅛".)



Large Rzeppa Constant Velocity Drive Line Joints have proved especially capable on 4-wheel drive applications. Speed fluctuation problems in the driven shaft have been eliminated through the patented principle of true, constant rotating motion. Precision instruments, too, are making use of the large Rzeppa Joint. Should you require a drive line joint large enough to be appropriate for aircraft dynamometer drive shaft application, look to Rzeppa. (O.D. as large as 16".)

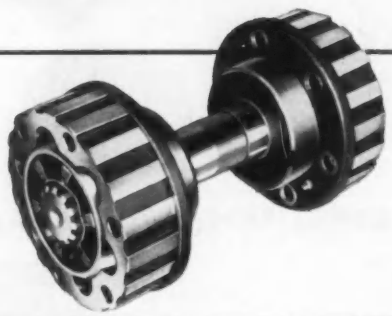
NEW APPLICATIONS

High angle efficiency, ruggedness, high capacity, and long life are among the reasons why Rzeppa Constant Velocity Joints are on the move. From the smallest to the largest they are being used on the drive lines of:

- Machine Tools
- Road Building Equipment
- Mining Equipment
- Steel Mill Equipment
- Oil Field Equipment
- Testing Instruments

TYPICAL DRIVE LINE APPLICATION:

Jointed shaft for independently sprung rear drive axle and propeller shafts for industrial applications. Solid or tubular shaft.



RZEPPA Constant Velocity UNIVERSAL JOINTS

For complete Rzeppa performance and engineering story—send for this catalog now.

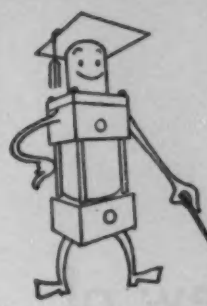
E-4

The Gear Grinding Machine Company

3939 Christopher • Detroit 11, Michigan

Miller

FLUID PRESSURE BOOSTERS

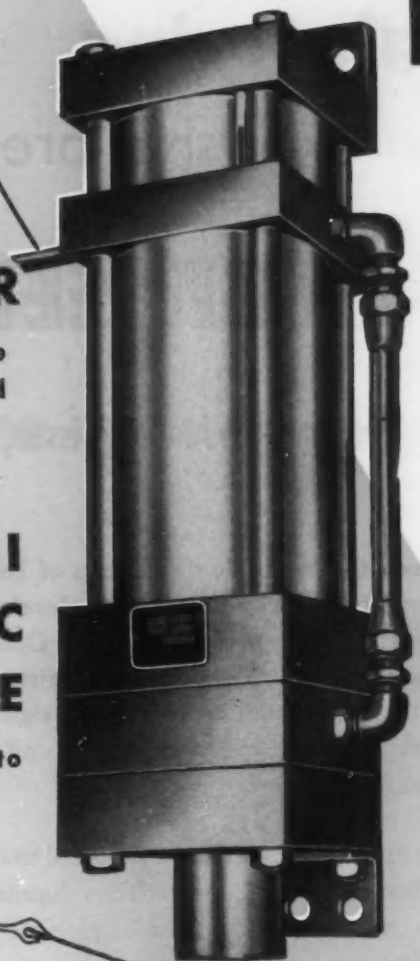


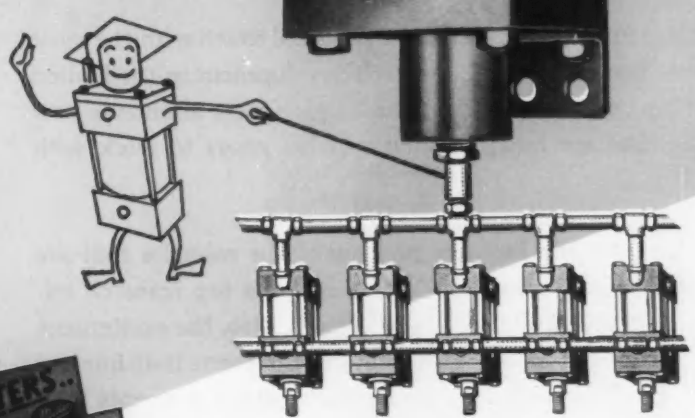
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

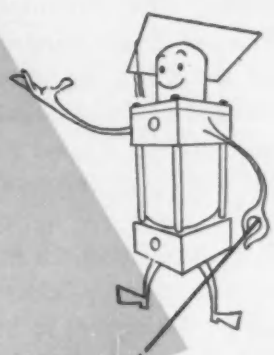
Output Range: 200 to 10,000 psi Fluid





- Save space, weight and investment cost by replacing pump installations in many applications.
- Less coslty to install, operate and maintain
- **Hold Pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide—at point of cylinder thrust—more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

NOTE: In addition to its most complete line of "Custom-Built" Boosters available on normal delivery, Miller offers 5" bore, 25 to 1 ratio, boosters for immediate delivery in either 6" or 12" stroke. Write for data and prices.



ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

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Miller

MILLER FLUID POWER CO.
(Formerly MILLER MOTOR COMPANY)

2002-04 N. HAWTHORNE AVE. • MELROSE PARK, ILL.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

the editors of
Product Engineering
invite you to an exclusive preview of

DESIGN ENGINEERING'S

. . . to be published in our January issue, as **Product**

This is uniquely a time when the dramatic discoveries of basic industrial research offer unlimited potentials for new product development. And as *Product Engineering* completes 25 years of service to Design Engineering, far too much lies ahead to dwell upon the past. We bring you in January, therefore, what you will surely find the most exciting, significant, imagination-stirring Special Report we have ever published . . . *all of it* devoted to the unrivalled future of your profession.

Our editors have, for many months, been in close personal touch with the most important and productive centers of basic research development in the United States. Objective: to bring you the startling, challenging facts about the new tools for product design that are now, or soon will be, *yours* to work with and apply.

We invite you to share with us this January preview of the miracles that are coming from the advanced thinking and work of America's top research engineers in private industry and elsewhere. Share with us, also, the excitement of looking ahead to the great new fields of product development that nuclear energy, germanium, irradiated plastics . . . and revolutionary concepts in a host of other sciences . . . now open to you, and to all members of the Design Engineering profession.

The future of the world is more than ever in the hands of research and design engineering. On *Product Engineering*'s 25th Anniversary, our January issue will give you the most stimulating confirmation of this fact you have ever had . . . and a wealth of forward-looking ideas you will use and apply for many years to come.

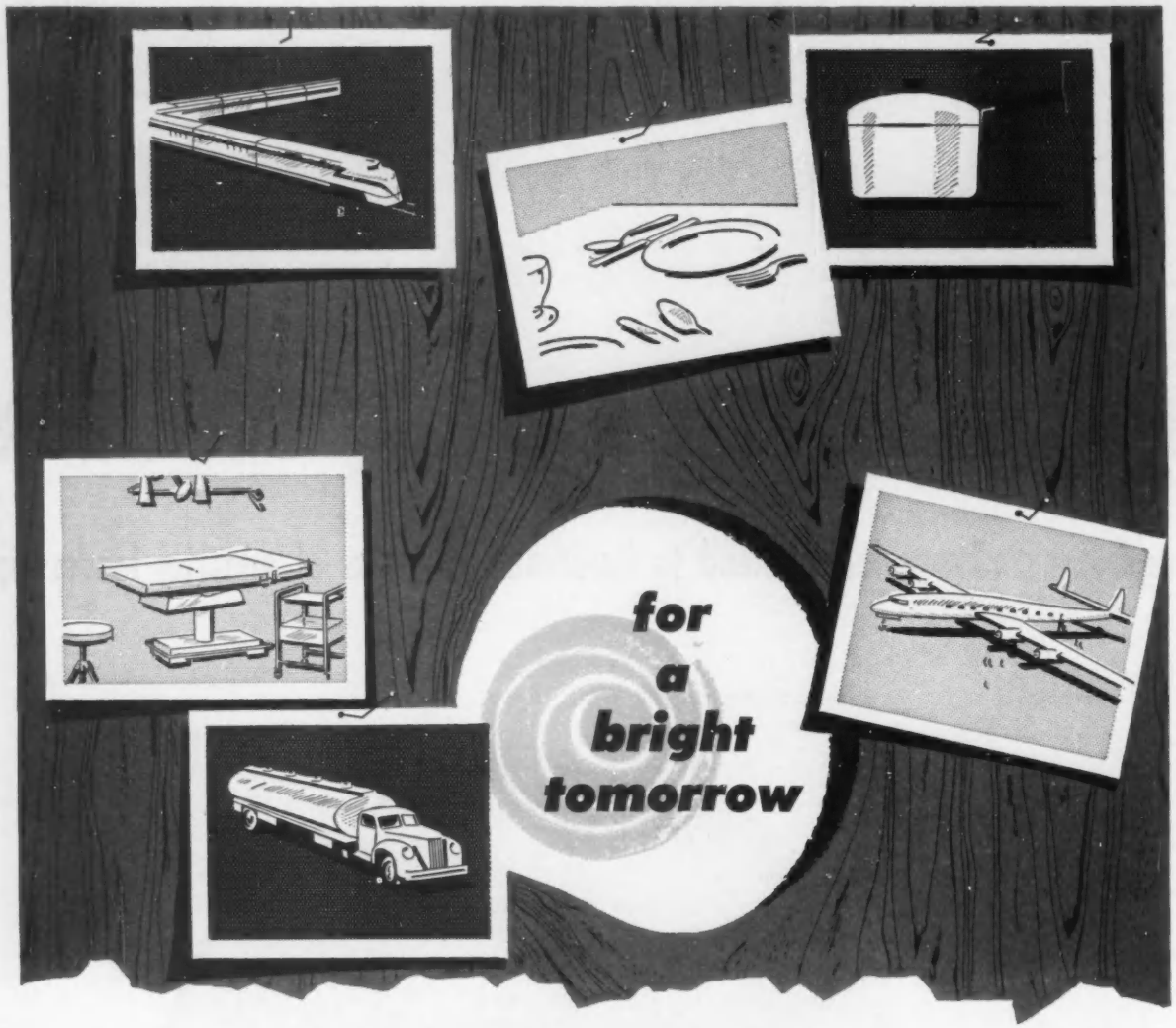
HORIZONS OF TOMORROW

Engineering looks ahead to its second 25 years of editorial leadership

The McGraw-Hill Magazine of Design Engineering
McGraw-Hill Building, New York 36

ABP ABC

Member of the Audit Bureau of Circulations
and Associated Business Publications



make it of CRUCIBLE stainless steel today

Crucible Rezistal® stainless steel *always* keeps its bright, attractive finish. For stainless has no surface finish to wear or chip away. It's *stainless* all the way through.

Yes, Crucible stainless steel is a beautiful but *practical* metal. That's why you'll find it being extensively used as architectural trim, in food processing equipment, in hospitals, on your car, or in your own kitchen. Actually, you'll find stainless profitably used wherever you turn, for if you can make it of metal — you can make it better of Crucible stainless steel.

Be sure *you* take advantage of the unique properties of Crucible stainless steel . . . its corrosion and wear resistance, exceptional strength, and ease of cleaning. A Crucible engineer can help you make the most of stainless for your individual application. A call will put him to work for you.

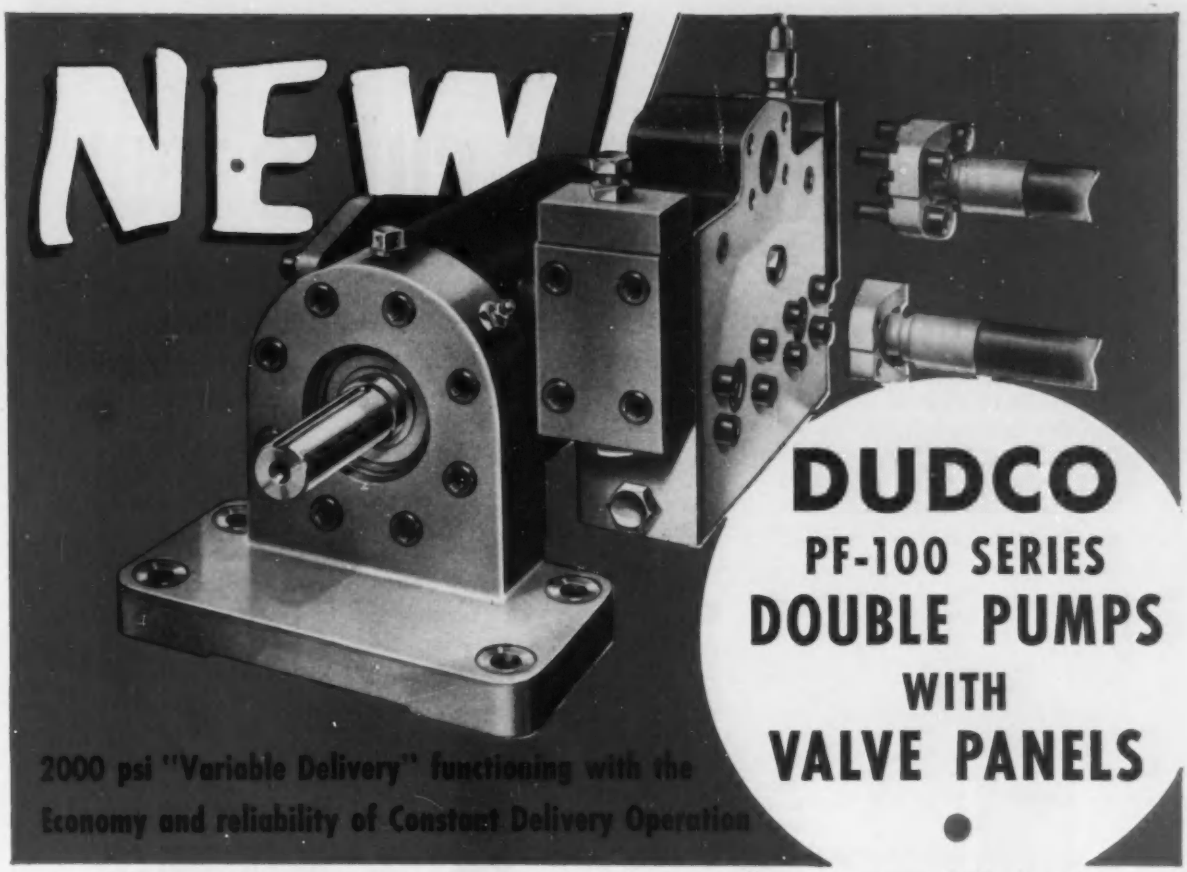
CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **STAINLESS STEELS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REX HIGH SPEED • TOOL • REZISTAL STAINLESS • MAX-EL • ALLOY • SPECIAL PURPOSE STEELS

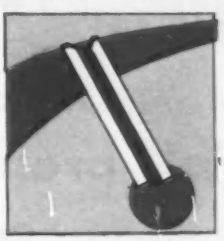
Canadian Distributor — Railway & Power Engineering Corp., Ltd.



DUDCO PF-100 Series Double Pumps with Valve Panels are versatile. They furnish *Fluid Power*, at continuous pressures to 2000 psi, either to two separate systems or to a single two-pressure circuit, controlled automatically in response to working pressures or remotely thru a pilot line.

DUDCO PF-100 Series Double Pumps with Valve Panels assure top system economy. They can be installed with almost "plug-in" ease. The Valve Panel contains the elements necessary for pressure regulation and flow control . . . valves, piping and connections in a system are reduced.

DUDCO Hydraulically Balanced, Dual-Vane Design Pumps give long, maintenance-free service at all pressures up to 2000 psi; with cost equal to that of low pressure pumps. DUDCO PF-100 Series Double Pumps with Valve Panels insure maximum circuit efficiency . . . only fluid required for effective circuit operation is pressurized. Wasteful by-passing of unneeded fluid is eliminated . . . horsepower is saved and fluid heating reduced. The regulator valves are internally piloted . . . this superior design allows more accurate adjustment and provides better control over a wider pressure range without the danger of spool sticking or over-pressurization.



TWO VANES ARE BETTER THAN ONE!

The hydraulically balanced DUAL-VANES in DUDCO Hydraulic Pumps as contrasted with conventional designs, maintain MULTIPLE AREAS OF CONTACT ON THE CAM RING . . . doubling the number of effective barriers to slippage and power loss. This patented principle is an exclusive DUDCO feature!

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1712 EAST NINE MILE ROAD • HAZEL PARK • MICH.

DUDCO DIVISION—
THE NEW YORK AIR BRAKE CO.
1712 EAST NINE MILE ROAD
HAZEL PARK, MICH.

I would like more information about the DUDCO PF-100 Series Double Pumps with Valve Panels. Please send me Bulletin No. DP-308.

Name_____
Company_____
Address_____
City_____ Zone_____ State_____

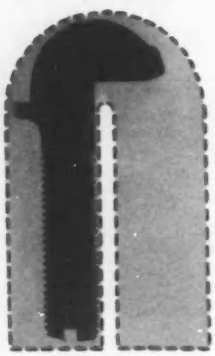
Eight operations cut to four

The old way:

The stud shown here was used by a tank manufacturer to blind feed into a tubing hole during assembly. Multiple diameters were required to hold the stud tight after insertion. To achieve this rather intricate shape, eight operations were originally required . . . until National was asked to study the problem.

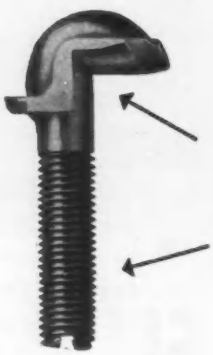
The National way:

Our "Special Products Service" showed this manufacturer how the stud could be produced to specifications *in only four operations* by cold-heading. Because National had the wide range of cold-heading equipment and specialized know-how needed to do the job, production costs were cut 50% . . . and substantial material savings resulted because cold-heading leaves a minimum of scrap.



OLD WAY

Bar stock bent in U-shape was machined to specifications in eight operations, with considerable waste of metal.



THE NATIONAL WAY

Head was upset into shape needed with multiple diameters.

Only four operations needed to complete stud by cold-heading and roll threading.

Bring your "Special" problems to National

Can we help you realize the same type of economy on *your* special fastener needs? Our "Special Products" representative will be glad to study your specifications. Write for free copy of National's "Special" fastener booklet.

Representatives in:
Chicago, Cincinnati, Detroit, New York, Philadelphia, Kansas City, Milwaukee, Rochester, Denver, St. Louis, San Francisco and Seattle.

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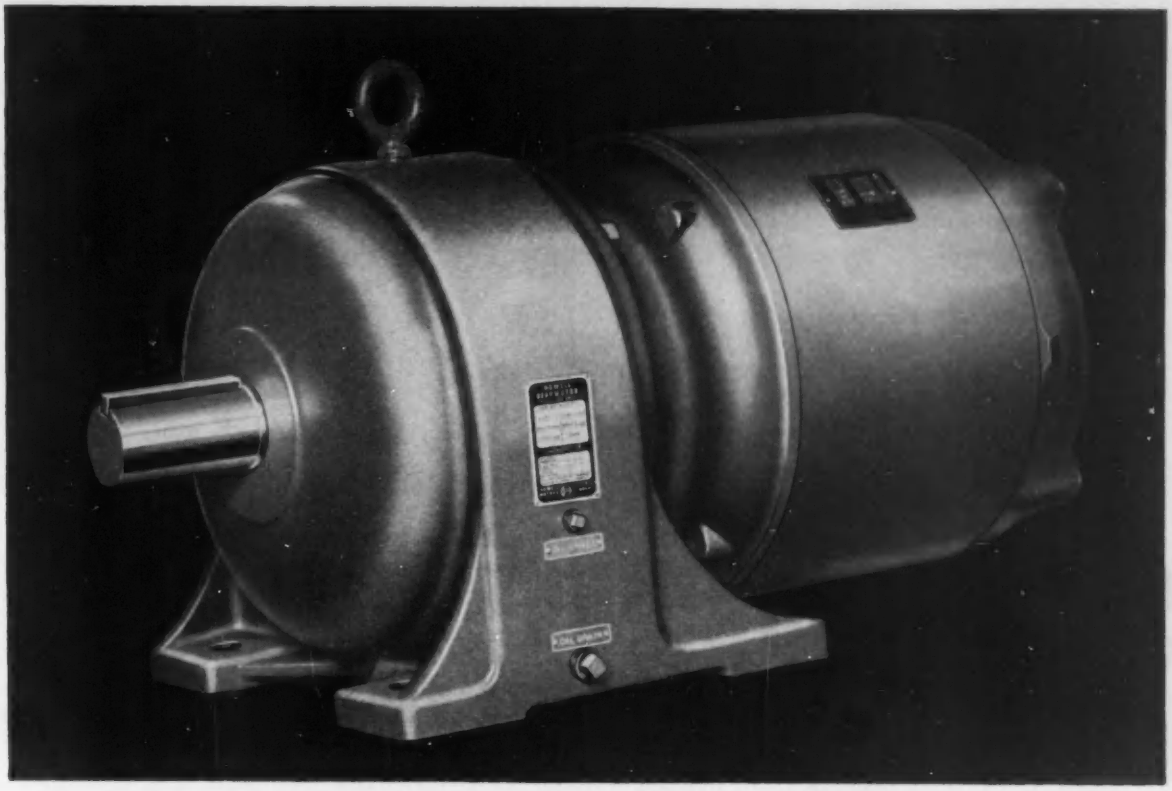
3423 South Garfield Ave., Los Angeles 22, Cal.

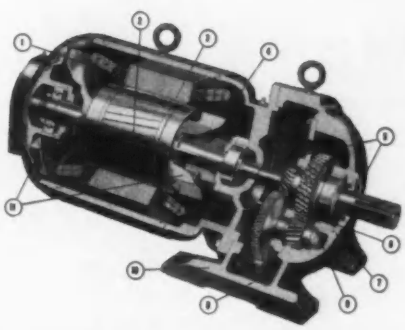
National PRODUCTS

Fasteners Hodell Chains Chester Hoists



The power you need at the speed you need it . . .

HOWELL GEAR MOTORS



11 reasons why Howell Gear Motors last longer, serve you better

1. High-quality insulation
2. Copper-clad rotor
3. Expert craftsmanship
4. High-quality coil varnish
5. Leakproof oil seals
6. Duti-Rated Lifetime Gearing
7. Unit case construction with integral bearing housings
8. Corner-mounted offset shaft
9. Large oil reservoir
10. Heavy, cast-iron construction
11. Superior cooling

New dependability, greater starting torque and top efficiency, with output speeds as low as 7.5 rpm. are now available in Howell Gear Motors.

This compact, single-unit motor may well be the answer to your gear reduction problems. Combining the finest in heavy duty industrial gearing with the best in motoring, Howell Gear Motors reduce drive failures and production downtime.

Howell Gear Motors use duti-rated, lifetime gearing, with file-hard tooth surfaces and tough, resilient cores. They are available in all types of enclosures, from 7.5 to 780 rpm. with a capacity range from 1 to 150 hp., in all three AGMA service classifications.

For full information on Howell Gear Motors, contact the Howell man in your area, or write the factory direct for Bulletin GM-1.

HOWELL Red Band MOTORS

HOWELL MOTORS

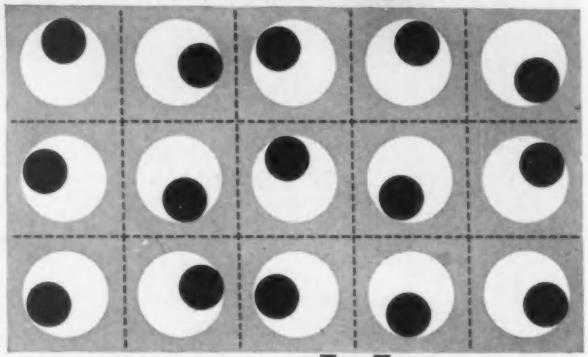
HOWELL ELECTRIC MOTORS COMPANY, HOWELL, MICHIGAN

MOTORS FOR INDUSTRY SINCE 1915

a quick release fastener that...

solves alignment problems

Illustration indicates infinite variety of positions assumed by screw fastener to compensate for misalignment.

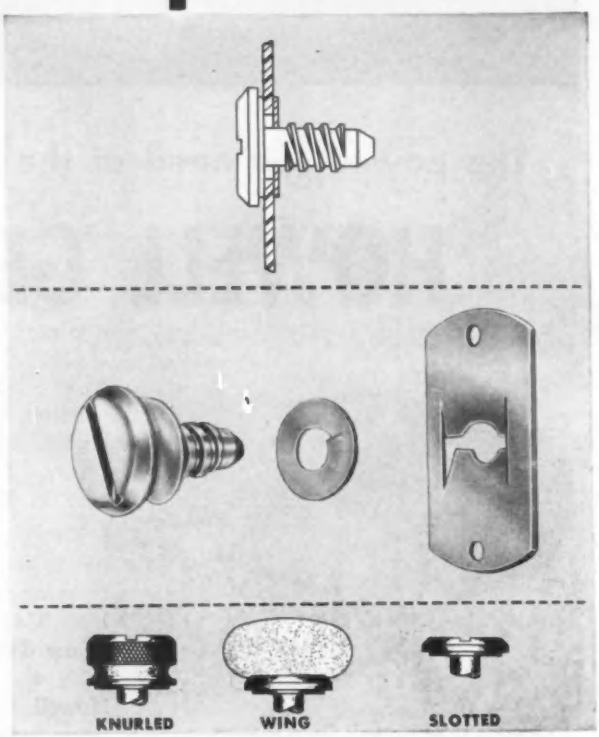


"FLOATING SCREW" ASSEMBLY COMPENSATES FOR OUT-OF-LINE DOORS AND PANELS

Installation of access doors and panels is made easy and production is speeded with Southco Quick-Release Fasteners. The wide alignment tolerances of Southco's "Floating Screw" adjust automatically to misalignment, saving mechanics' time. Also, the Southco "Floating Screw" insures accurate and uniform closure throughout the life of the equipment, compensating for warpage and bends resulting from hard usage.

One Southco grip length can meet most panel thicknesses on the average assembly—no need to specify many fastener sizes!

For complete information, write Southco Division, South Chester Corporation, 236 Industrial Highway, Lester, Pa.



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SOUTHCO®

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

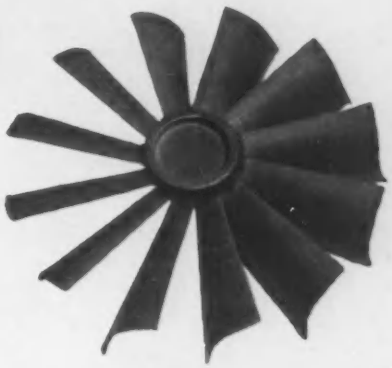
OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

Mass-Produced at Less Cost...

by HAYNES Investment Casting

Trade-Mark



PRODUCED FOR 74 PER CENT LESS

Originally this turbine wheel was machined from a 20-lb. forging to a final weight of a little over 1 lb. Now the part is produced by investment casting and only 2 oz. of metal is removed. Investment casting has brought about a 74 per cent reduction in production costs by saving strategic metal and machine time.

COST CUT 60 PER CENT

This investment-cast motor mount was made in a high-strength alloy at 60 per cent less than the cost of a forging. The mount bears the entire weight and torque of a 100-lb., 15-horsepower aircraft starter motor. The investment-cast parts require only four simple finishing operations.

ASSEMBLY COSTS REDUCED

Investment casting made it possible to produce this cylinder head in one piece, eliminating extra assembly costs. Machining was reduced to a minimum. The design of the part is special to investment castir g. The castings weigh about 25 lb. and are 7 in. in diameter.

HAYNES *investment castings can solve some of your own production problems. For more information, contact the nearest Haynes Stellite Company office listed below.*

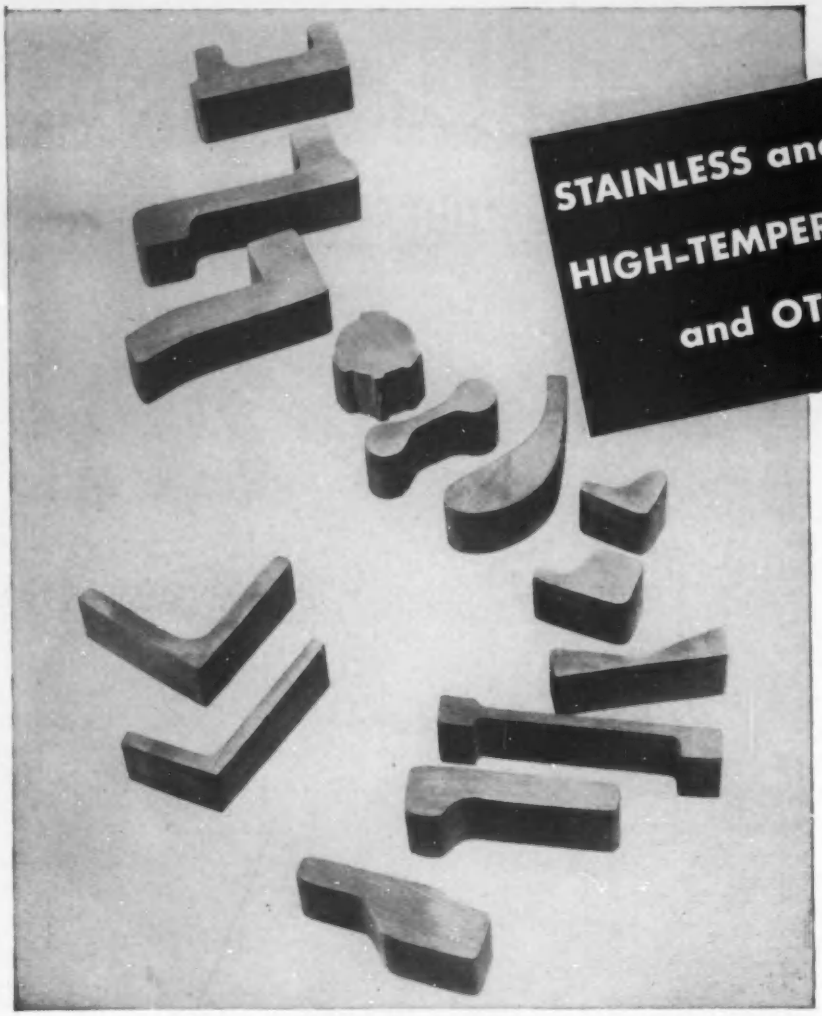
"Haynes" is a registered trade-mark of Union Carbide and Carbon Corporation.

HAYNES INVESTMENT CASTINGS

TRADE-MARK

Sound, dense, high-strength parts available in cobalt-base alloys, nickel-base alloys, iron-base alloys, stainless steels, and alloy and carbon steel.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles—New York—San Francisco—Tulsa



A-L HOT EXTRUSIONS (solid and hollow) may solve problems for you

Help! (Dept. PE-60)

We have a parts problem that hot extrusions might solve. Let's see an AL representative for facts and figures.

- ☐ STAINLESS STEEL
- ☐ TOOL STEEL
- ☐ HIGH TEMPERATURE STEEL
- ☐ OTHER STEELS

Name_____

Company_____

Address_____

Where can these leading advantages of hot-extruded special alloy steels apply to your production?

1. Hot extrusions require very little finishing before use, even in the case of involved shapes. The scrap loss is small and you can buy raw materials closer to finish size. You buy less high-cost steel, cut away less of it . . . save both in time and material cost.

2. The range of shapes, solid or hollow, which can be hot-extruded is almost infinite. They can be easily and quickly produced in any quantity. Dies for new or experimental parts cost little and can be made up fast.

● We're ready to serve your needs with hot extrusions in any grade of stainless or high temperature steel, many tool steel grades and other steels. Call us in to help. ***Allegheny Ludlum Steel Corporation, Oliver Building., Pittsburgh 22, Pennsylvania.***

Leading Producer-High Alloy Steels

Allegheny Ludlum

WBD 9310

AL® TIME-TESTED STAINLESS STEEL

DU PONT
REG. U.S. PAT. OFF.

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 9 — 1954

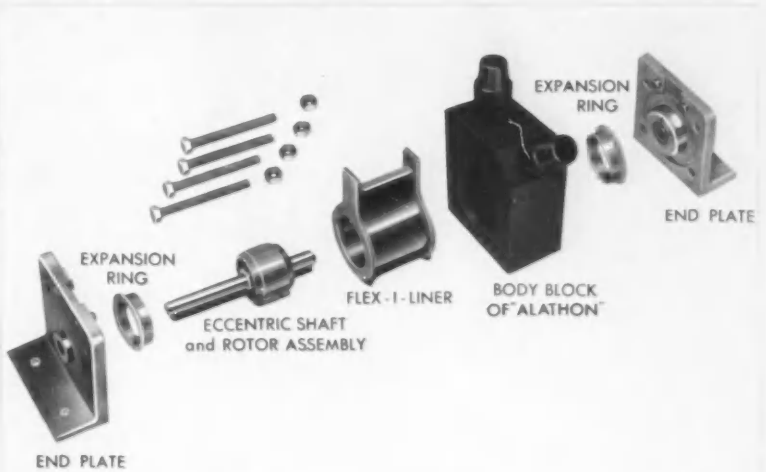
New Pump Using Du Pont ALATHON® Needs No Stuffing Boxes, Shaft Seals, or Check Valves

"Alathon" resists corrosive fluids, abrasive slurries

THE patented "Flex-i-liner" pump shown at the right features a body block of molded Du Pont "Alathon" polyethylene resin. It is designed to handle such industrial fluids as acids, alkalies, solvents, biological solutions and food products. Corrosion and contamination are eliminated because "Alathon" is resistant to chemical attack.

Fewer Parts

Vanton Pump & Equipment Corporation has designed a pump with fewer parts and high efficiency. Stuffing boxes and shaft seals are eliminated, so external leakage is avoided. The pump is self-priming, needs no check valves and gaskets. Process industries can use the "Flex-i-liner" for a wide range of applications. The body block of "Alathon" will resist concentrated hydrochloric, sulfuric and hydrofluoric acids, some oxidizing agents and caustics. It also stands up well against abrasive slurries.



"Flex-i-liner" pump, manufactured by Vanton Pump & Equipment Corporation, New York City, is shown above in an exploded view. Corrosion and contamination problems are avoided with this pump—thanks to a body block of corrosion-resistant Du Pont "Alathon" polyethylene resin, molded in one piece.

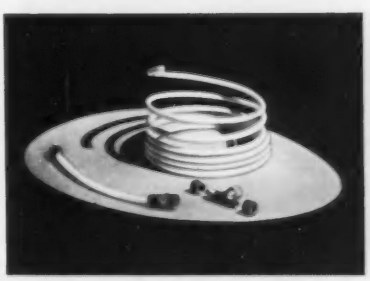
Other Properties

Du Pont "Alathon" has properties which can help solve a wide variety of design and operating problems. The lightness, toughness, corrosion-resistance, good dielectric properties, and easy moldability of "Alathon" are important advantages for the design engineer to consider. For more information about "Alathon" fill out and mail the coupon on the reverse side.

OVER

Thinwall tubing of Du Pont TEFLON® makes assembly easier

EXTRUDED thinwall tubings of Du Pont "Teflon" tetrafluoroethylene resin are easy to handle—they can be cut with a knife, and bent by hand. Because "Teflon" has a smooth, wax-like surface, the tubing slips into position easily. The chemical inertness, resistance to heat and cold, strength, and excellent dielectric properties of "Teflon" make this tubing useful for a wide range of electrical and chemical applications.



Flexible tubing of Du Pont "Teflon" is manufactured by the Halogen Insulator and Seal Corp., Franklin Park, Ill. This tubing is lightweight, chemically inert, has excellent dielectric properties, and a working temperature range of −450°F to 500°F.

DU PONT
REG. U.S. PAT. OFF.

PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NO. 9 — 1954

Bearings of TEFLON® are self-lubricating

DESIGN engineers have a unique bearing material in Du Pont "Teflon" tetrafluoroethylene resin. "Teflon" is self-lubricating, any friction produced being no more than that of ice against ice.

The coefficient of friction of "Teflon" stays constant through load changes and temperatures up to 620°F. It has zero water absorption—won't shrink, swell, crack or harden. Mechanically strong, "Teflon" has good impact strength and abrasion-resistance under normal conditions of speed and load.

For more information about this versatile engineering material, its use for bearings, and their applications, mail the coupon below.

Investigate Du Pont engineering materials in your product development programs

ONE OF the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

Coil assembly of "Zytel" resists high surge voltage

DU PONT "Zytel" was chosen by General Electric to encapsulate the motor coil in their combination watthour meter and time switch. "Zytel" nylon resin protects the motor coil from a 7000 volt 60 cycle and a 10,000 volt surge to ground. It withstands severe shock, cycling between 100°C. and −40°C. The encapsulation is accomplished by a relatively simple molding cycle, rapidly and economically. The corrosion resistance, compactness, and attractive appearance of "Zytel" nylon resin are other important reasons for specifying this engineering material.

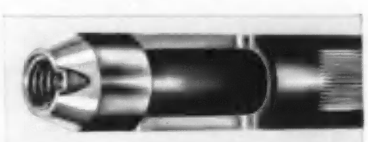
Motor coil for General Electric watthour meter is encapsulated with Du Pont "Zytel" nylon resin. Encapsulation is accomplished by rapid injection molding.

Du Pont "Zytel" nylon resin is a valuable material for the design engineer. Its lightness of weight, abrasion-resistance, and dimensional stability, as well as the dielectric properties of "Zytel," are being used in a wide variety of applications. Use the coupon at the bottom of the page for complete property data on this unique engineering material.

Unique lighter is molded of tough, transparent LUCITE®

A GLANCE will tell if you need fluid or flints for this attractive lighter molded of transparent Du Pont "Lucite" acrylic resin. "Lucite" is injection-molded to provide the body. Articles of "Lucite" such as this lighter can be molded economically in a wide variety of transparent, translucent and opaque colors.

A lighter you can see through! It's molded from Du Pont "Lucite" acrylic resin. Manufactured by the Santay Corporation, Chicago, Illinois.



"Production costs reduced"—that's the report of the Heli-Coil Corp., Danbury, Connecticut, now that they've switched to molded Du Pont "Zytel" nylon resin for their pre-winder tool. This tool, used to screw corrosion-resistant, precision thread inserts into tapped holes, is 75% lighter because of "Zytel". The tough, abrasion-resistant threads of "Zytel" wear twice as long as the material previously used.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 1012, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel";* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite". I am interested in evaluating these materials for:*

NAME _____ POSITION _____

COMPANY _____

STREET _____

CITY _____ STATE _____

TYPE OF BUSINESS _____

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)
†"Zytel" is the new trade-mark for Du Pont nylon resin.

For heavy-duty arcing loads....

Specify ELKONITE® CONTACTS

Elkonite Contacts combine these characteristics in a way that can't be equalled...

- **Good Conductivity**
- **Resistance to Sticking**
- **Resistance to Arc Erosion**
- **Impact Strength**

Elkonite is the registered trade mark for a series of unique materials developed by Mallory, and manufactured from metal powders. The Elkonite process combines metals which will not alloy, producing new materials with properties often superior to their constituents.

Elkonite combines the arc-resistance of tungsten, molybdenum, or their carbides with the high current-carrying ability of copper or silver. Thus, Elkonite Contacts give excellent service under heavy-duty arcing loads where other materials would fail.

The secret of Elkonite superiority is the *technique by which the materials are combined.* Specifying an equivalent chemical composition will not assure the same physical properties. For dependable service in all heavy-duty circuit interrupting equipment, specify Mallory Elkonite Contacts. The Elkonite family of materials includes a variety of compositions for a wide range of contact requirements.

In Contacts . . .
Expect More . . . Get More
from **MALLORY**

NEW CONTACT CATALOG

Write for your copy today. It includes a discussion of Mallory materials and facilities for producing contacts and contact assemblies for every service . . . as well as valuable technical and design data.

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Electromechanical—Resistors • Switches • Television Tuners • Vibrators
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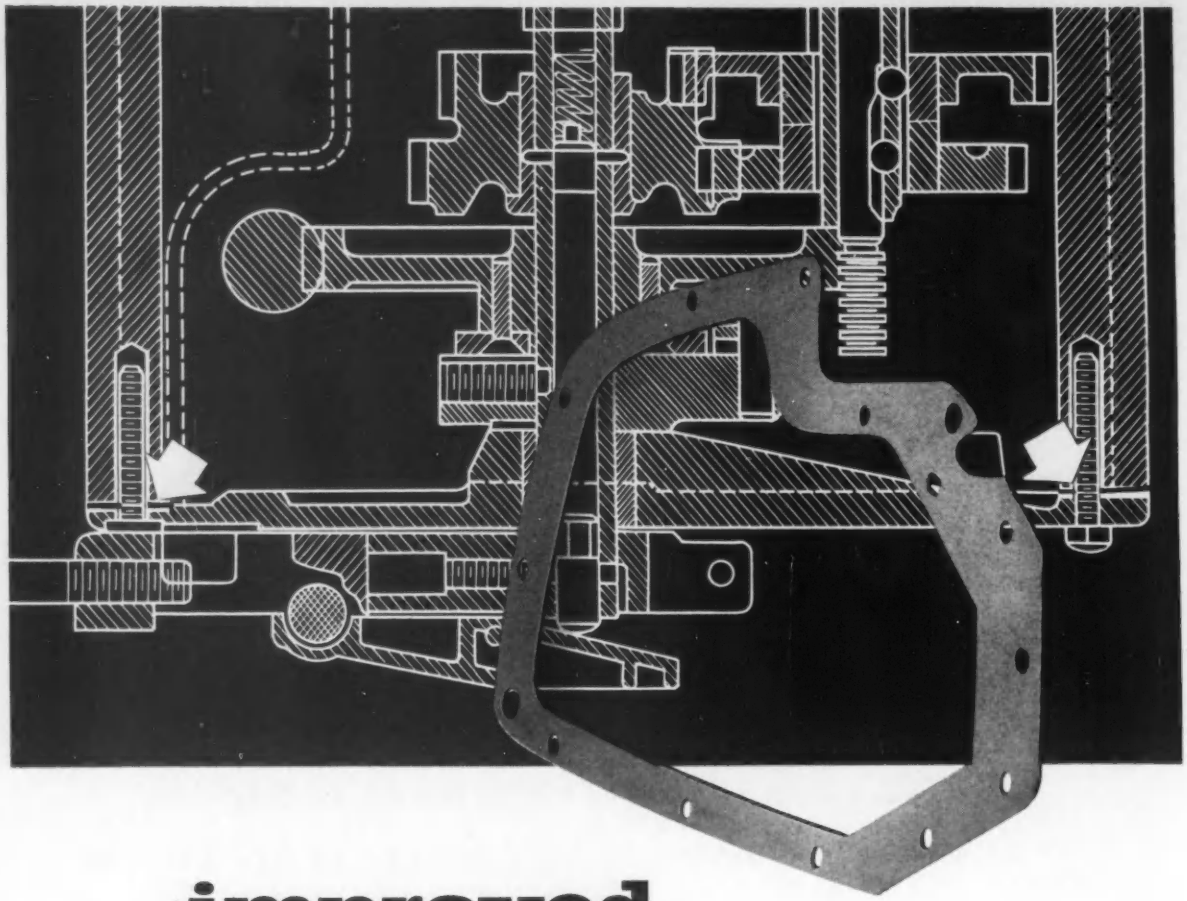


improved fiber gasket

withstands enamel baking cycle, maintains tight seal

Gasket failures can occur before a product leaves the plant—during assembly and finishing processes. And such failures can be costly.

This was the experience of a manufacturer of electric ironers. Each ironer gear case was put through an enamel baking cycle after it was assembled. The original gasket being used between the aluminum gear case and cover generally sealed well, both before and after being heated. But in an effort to reduce costs, the manufacturer tested other less expensive gasket materials. Each one, however, permitted torque loss and leaked grease during and after the enamel baking process.

Then a new, improved fiber gasket material was tried—Armstrong CS-301 Accopac®. It maintained torque in spite of baking heat. No grease leaks developed. The manufacturer lowered costs and was assured a dependable, long-lasting seal.

Accopac withstands normal manufacturing and service conditions because of the way it's made. Cellulose fiber and cork are blended with a non-extractable latex binder by a patented beater saturation method. The finished material is dimensionally stable, uniform, and highly compressible.

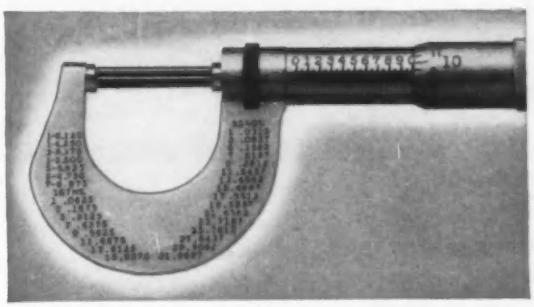
Where can you use Accopac? Use it wherever you need extra dependability in a low-cost gasket material. Although relatively new, Accopac already is widely accepted for sealing pumps, engines, air compressors, aircraft devices, automotive equipment, gear housings, and household appliances.

FREE 24-PAGE GASKET MANUAL—Look for "Armstrong's Gasket Materials" in Sweet's product design file . . . or write for your personal copy to Armstrong Cork Company, Industrial Div., 7012 Irvin Street, Lancaster, Pennsylvania. **And be sure to specify Armstrong Gasket Materials when you order from your gasket fabricator.**

Armstrong Accopac

*consistent quality is as important in the pin as in the gear

To function effectively, a spring pin must drive easily into holes drilled to normal production tolerances, compressing as driven. To drive easily, hold firmly and fit flush, the pin —*every* pin—must meet the strict requirements of specifications such as those prepared by the SAE and the Military Services.



Since failure of a pin can be as costly as a failure of any other precision part, it is important to check the pins *you* buy for uniformity . . . uniformity of diameter and length, shear strength, hardness, insertion and removal forces, and recovery of diameter.

Rollpin has been tested many times—by many manufacturers—with a consistently high performance record. It has been widely recognized as the "quality" fastener of its type. In this case, quality can be—and should be—measured. We strongly urge that you test for quality when buying spring pins.

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. R28-122, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send the following free fastening information:

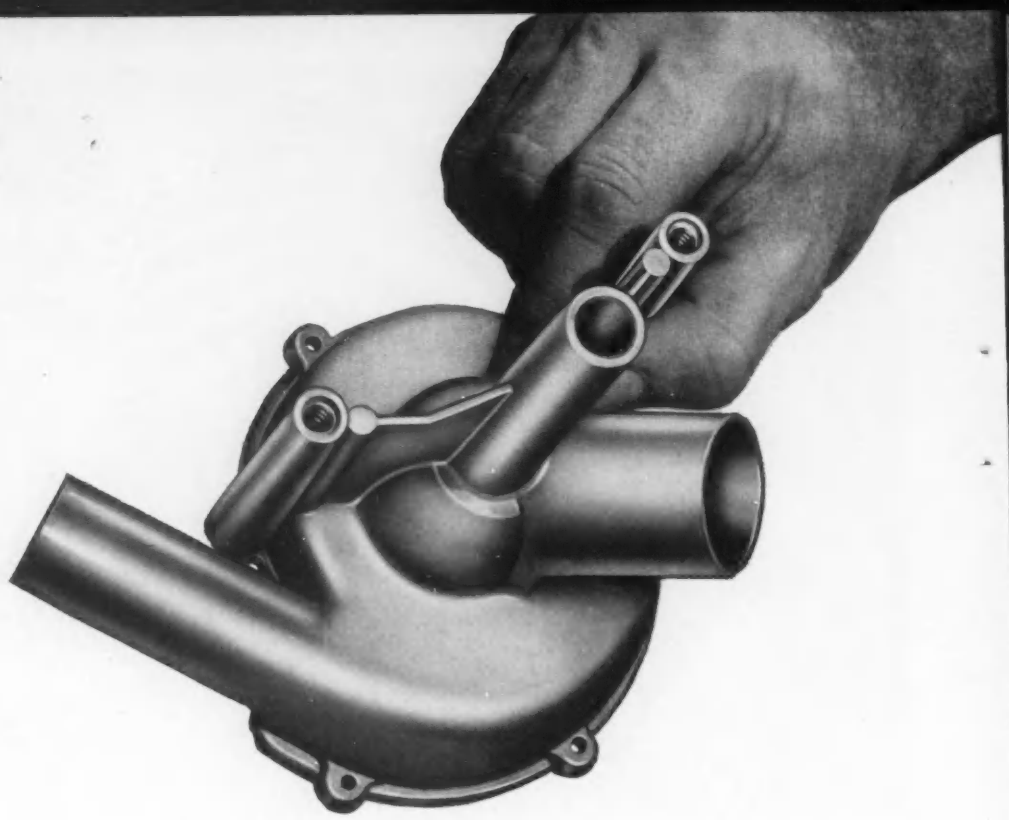
☐ Rollpin samples
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State_____



this die casting was 44 years in the making...

● We Began "Setting Up" for This Job in 1910—and That was None Too Soon!

Slow work? Not exactly . . . it required only days to produce the casting itself. But it took 44 years of experience to gain the "know-how" needed to do the job. Why not put that experience to work for you? Whatever type of die castings you need—small or large, simple or intricate—count on *Stewart* to meet your most rigid specifications . . . on time.

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Designing • Engineering • Die Making
Metallurgical Control • Most Modern Die Casting Equipment • Complete Machining, Polishing and Assembly Facilities.

44 years of helping industry to "Make It Better"

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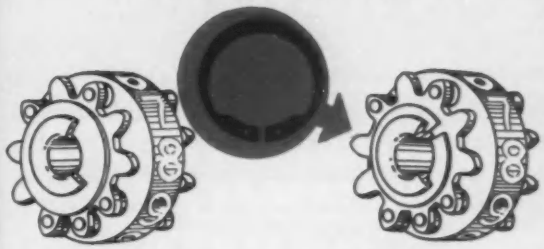
Waldes Truarc rings replace old-fashioned fasteners . . . save assembly time...end scrap loss...increase operating efficiency

This is the Monroe Calculator

...precision-engineered business machine made even more efficient, and less costly to manufacture through the use of Waldes Truarc Retaining Rings.

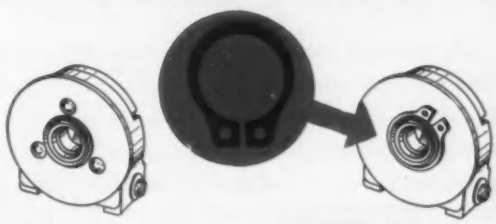
Multiplier Dial Assembly



Old Way. One-piece assembly was spun together. Spinning operation was costly, resulted in high scrap loss.

Truarc Way. Two-piece assembly is held together by one Truarc Ring (series 5108). Rejects: practically zero.

Electric Motor Governor



Old Way. Collector Disc assembly was formerly riveted, requiring skilled labor. Riveted Collector Disc could not be removed in the field.

Truarc Way. Truarc Ring (series 5100) replaces rivets, saves labor, material...improves Collector action. Collector Disc is easily replaced.

Intermediate Gear Shaft

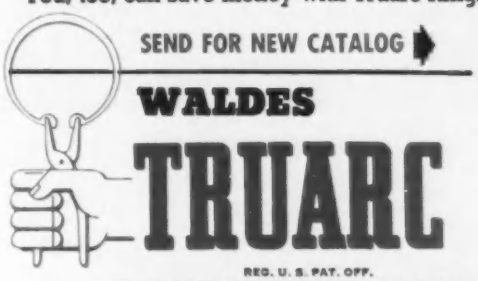
Old Way. Washer riveted on end of assembly for zoning control. Costly, troublesome, hard to obtain critical zoning required.

Truarc Way. Truarc E-Ring (series 5133) cuts assembly time, virtually eliminates rejects and final assembly and zoning problems.

Monroe Calculating Machine Company, Orange, N. J. uses various types and sizes of Waldes Truarc Retaining Rings. Use of Truarc has helped eliminate scrap losses, saved on material and labor, and resulted in increased operating and servicing efficiency of the product. Monroe plans to use Truarc Rings for every possible fastening operation on their entire line!

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc Engineers for individual attention, without obligation.



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TRUARC

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For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

1-NY-126

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Please send me the new Waldes Truarc Retaining Ring catalog.

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USS "T-1", A Nickel Alloy Steel, Helps Save Money

Lips of Nickel Alloy Steel show 11 times the life of the previous material used . . . in Clamshell Bucket

T-1 steel not only replaced a more expensive material here, but also outlasted it by 11 to 1. In this application, T-1 is still on the job after 11 months, handling open hearth sinter, whereas a wear resisting steel cracked and failed in 30 days under abrasion, impact and operating temperatures of 500 to 600°F.

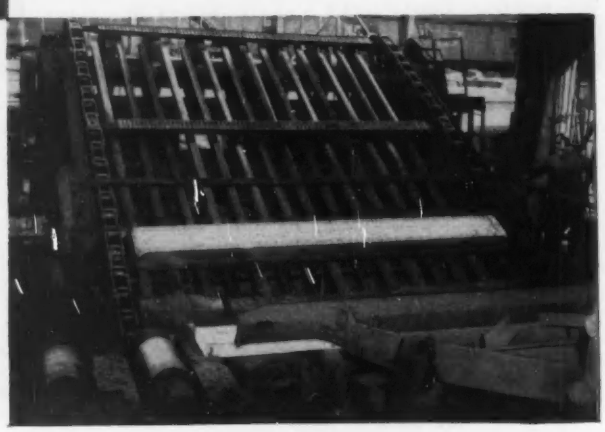
4 to 1 Better Service than carbon-manganese steel . . . in Skip Car Bottoms, Sides and Bail Plates

On skip cars handling coke, ore and limestone, T-1 steel bottoms, sides and bail plates are saving money. So far they have outlasted carbon-manganese steel 4 to 1. This four-fold longer life means more use per dollar for T-1 steel even though its initial cost is about twice that of the steel it replaced.

Unmatched Performance under heat and wear . . . in Blooming Mill Conveyor Chain

Here's a 40" blooming mill conveyor chain for lifting hot slabs at U. S. Steel's Ohio Works. Various materials used for chain failed under the severest impact conditions imaginable, caused by falling or jammed hot slabs. Notice the good appearance of the present chain made from T-1 steel. This product has far outlasted all previously used materials.

These applications in U. S. Steel's Ohio Works show how T-1 steel can reduce your maintenance, operating and repair expenses under like conditions. Write for complete details.



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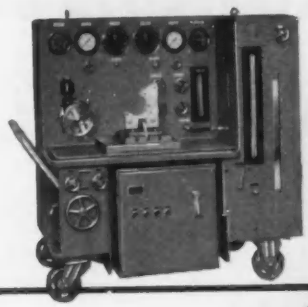
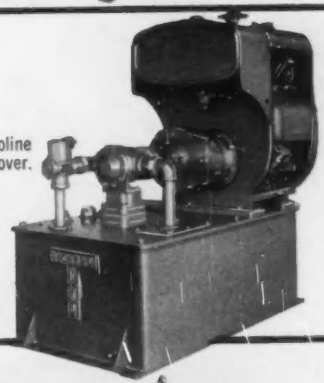
Pulpit type power unit provides full visibility, easy accessibility.

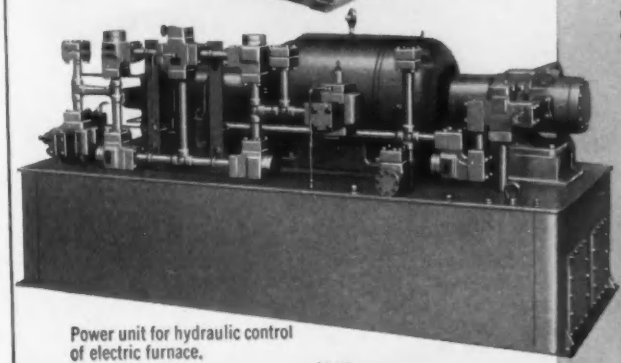
Compact power unit showing gasket-mounted valves.



Portable power unit for testing pumps.



Power unit with gasoline engine as prime mover.



Power unit for hydraulic control of electric furnace.

6837

Individually Designed to Meet *SPECIFIC* Needs

VICKERS® *Custom Built* HYDRAULIC POWER UNITS

DEPENDABLE PERFORMANCE

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REDUCE INSTALLATION COST AND TIME

EASIER SERVICING

BETTER APPEARANCE

Vickers engineers approach the design of a custom-built hydraulic power unit from the standpoint of the customer's INDIVIDUAL needs. The sole objective is to meet HIS requirements with the best hydraulic "package". This assures the most compact, efficient and convenient hydraulic equipment for the particular machine.

A Vickers Hydraulic Power Unit includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls, etc., as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings, etc.). Hydraulic connections can be grouped in a convenient manifold.

In addition to the advantages mentioned above, each Unit is pretested at the factory and ready for immediate operation. Vickers undivided responsibility for the entire hydraulic control system is also an important feature to both the machine builder and his customer. Write for Bulletin 52-45.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

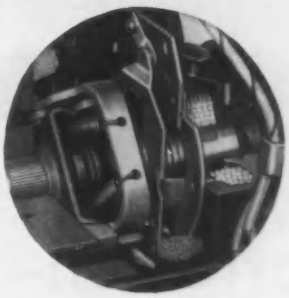
Wagner®
ELECTRIC MOTORS
... the choice of leaders in Industry

for single-phase motor applications....

Wagner Type RK, resilient-mounted capacitor-start induction motor in the new 56 frame that is used for ⅓, ½ and ¾ hp ratings. Smaller fractional ratings, and integral sizes from 1 through 5 hp, are also available.

Wagner rigid base Type RK motor, in the new 56 frame size. The formed steel base is securely welded to the rolled steel frame to produce a strong, rigid mount that will not get out of alignment.

Frames for these motors are made of thick rolled steel, with machined beads on each end which accurately position the end plates. The frames have no openings, and are treated inside and out to prevent rusting.



These motors are equipped with the exclusive Wagner quick-break switch that disconnects the starting winding and capactor from the line when the motor approaches operating speed. It operates over a million times without trouble.

..Wagner Type RK is the Right Kind of motor to use

Wagner capacitor-start induction motors are the *right kind* of motors to use for most single-phase applications. They have become first choice of many leading manufacturers of air conditioners, refrigerators, freezers, water pumps, motor-driven tools, and are used in many other similar fractional or integral horsepower applications.

These motors offer low maintenance cost—only a minimum of servicing is required—and they give many years of reliable service with unusual freedom from vibration and noise.

These motors are available in open or totally-enclosed types—sleeve or ball bearing, with rigid or resilient bases or machined end plates for flange mounting. The rotor squirrel-cage is of aluminum, cast under pressure. The end plates are of sturdy cast iron construction and are drip proof. Type RK capacitor-start induction motors feature steel-backed babbitt lined bearings, roomy oil wells packed with long strand wool yarn, and dependable quick make-and-break switches which have proved their ability in service.

* * *

When you standardize on Wagner Motors—you get the advantages of a liberal warranty . . . of nationwide service facilities, with on-the-spot service, replacement motors and parts available from 25 Wagner-owned Service Branches and more than 750 Authorized Service Stations. You can also choose from a wide variety of types and sizes—single-phase or poly-phase—(from 1/125 to 400 hp). Bulletin MU-185 gives complete information—write for your copy.

Wagner Electric Corporation EST. 1891

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6406 Plymouth Ave. • St. Louis 14, Mo., U. S. A.

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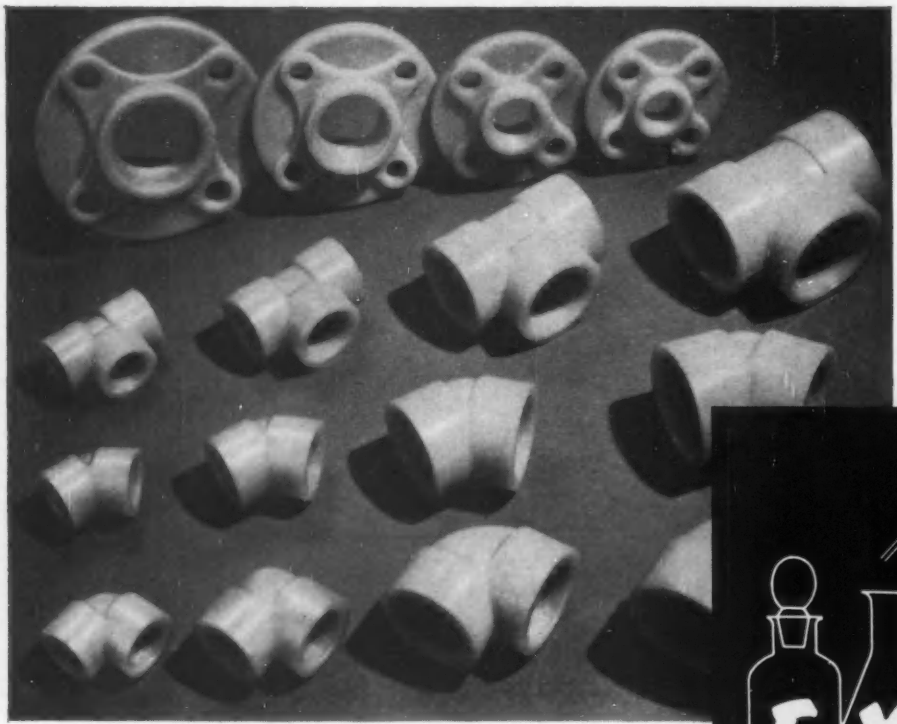
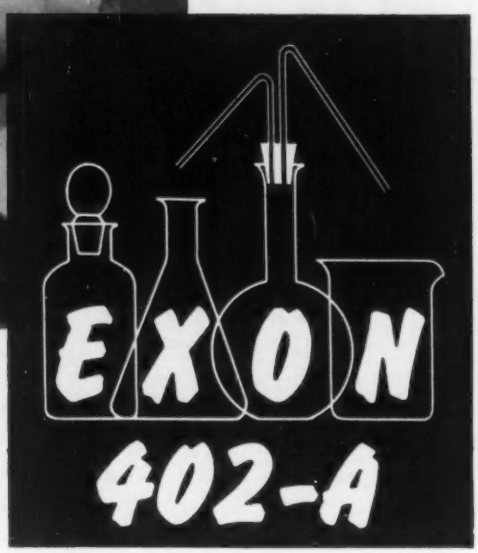
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

M54-12

unplasticized P.V.C. now can be **MOLDED** for unlimited low-cost, corrosion-resistant applications





—using Firestone

Exon 402-A **truly is a most versatile resin!**

It makes possible molded unplasticized P.V.C.—opens wide new horizons for many low-cost, high-strength, corrosion-resistant applications —in an infinite variety of sizes and shapes.

It's no great news that unplasticized P.V.C. pipe has long been available. But it is exciting news that you can now use Exon 402-A to quickly turn out pipe fittings of Standard I.P.S. sizes ½" through 4", slip-fit or threaded. The products shown here are absolutely uniform . . . with excellent chemical resistance and inertness. Imagine the limitless possibilities this material offers in the pipe field alone!

Exon 402-A used to mold products made of unplasticized P.V.C. could easily end *your* search to cut costs in processing tough, corrosion-resistant products. For complete details on the many advantages, uses and applications of Exon 402-A, contact Firestone today.

for complete information
on the entire line
of Firestone ***EXON*** resins,
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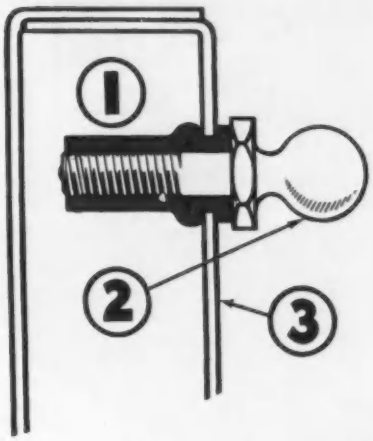
One B. F. Goodrich RIVNUT solves 3 fastening problems!

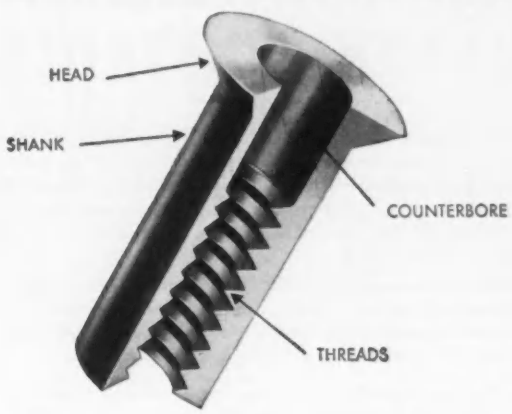


A RIVET WAS NEEDED for doors of metal cabinets that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment, and 3) could be installed after enameling. A B. F. Goodrich Rivnut proved the perfect answer.

A flat-head Rivnut is inserted in the sheet metal door. Working from one side, one man can upset Rivnut in 2 seconds with easy-to-operate heading tool. Bulge formed in Rivnut shank grips the metal tightly. The knob of the catch is then threaded into the clean, still-intact Rivnut threads. Rivnuts are installed after enameling without marring the finish.

This simple solution saved many man-hours on the job. If you have a fastening problem, why not put it up to Rivnut engineers? Write to The B. F. Goodrich Company, Dept. PE-124, Akron, Ohio.

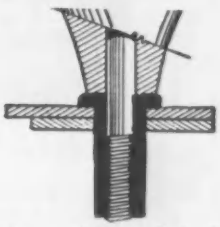
THIS IS A B. F. GOODRICH RIVNUT . . . . THIS IS HOW IT WORKS



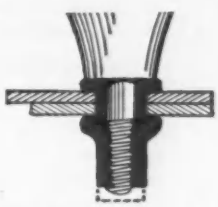
This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

The Rivnut provides a large bearing surface, requires only a small hole, and can be installed after enameling without marring the finish.

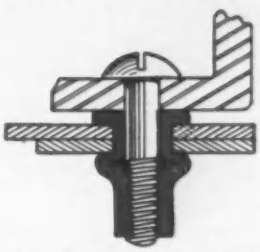
1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2. Rivnut is inserted, head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, threads are still clean and intact, ready for screw attachment.

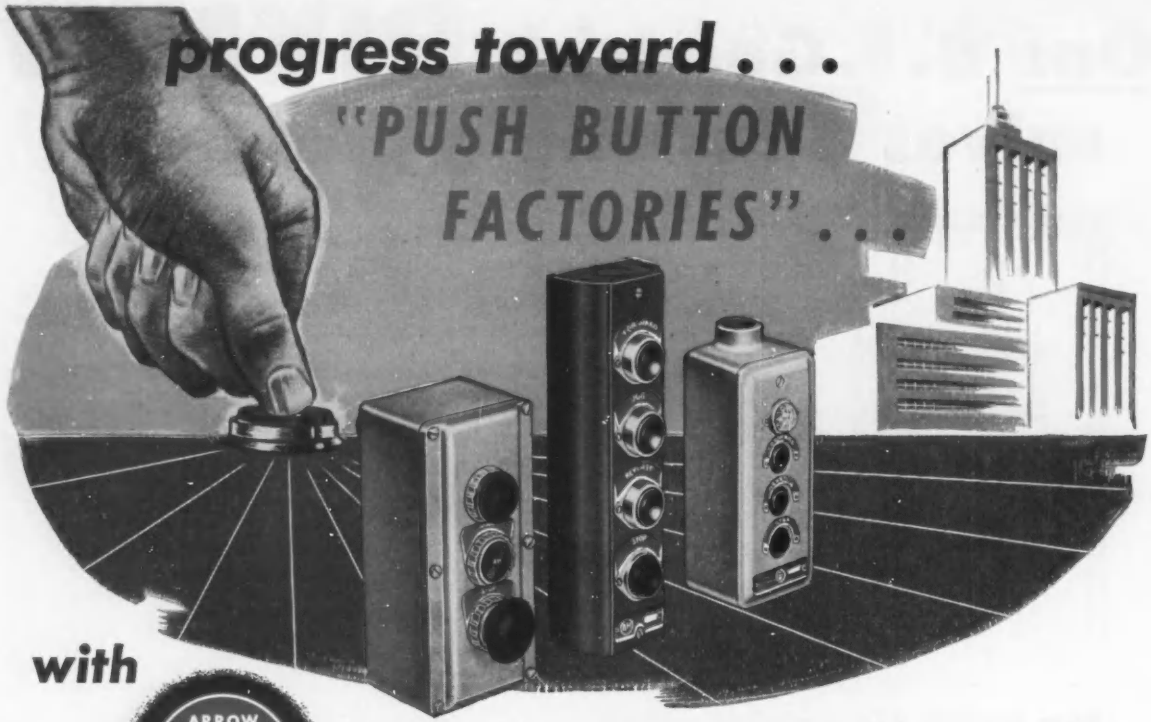
B.F.Goodrich RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dpt. PE-124, Akron, Ohio.

progress toward . . . "PUSH BUTTON FACTORIES" . . .



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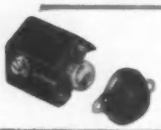
PUSH BUTTONS

SELECTOR SWITCHES

PUSH-PULL or PUSH-AND-TURN BUTTONS



PILOTS

The trend in industry is toward complete automation . . . "Push Button Factories". The greater **your** progress toward automation, the greater will be your need for Push Button Controls that can be assembled easily and quickly to meet ever-changing conditions. A-H Push Button Controls fill this need completely. They are completely interchangeable within the 3 basic lines offered . . . STANDARD DUTY . . . HEAVY DUTY . . . OIL TIGHT . . . and are equally adaptable to local or remote control.

Advancement toward automation means greater centralization of control . . . and creates a demand for maximum performance in minimum space. A-H control units are tailor-made for this job. A large number can be assembled in special small-size, space-saving panel boards. And, like all A-H controls, these units set new standards for dependability.

STANDARD DUTY LINE . . . Compactness assures easy mounting in convenient locations. Suitable for use under all usual operating conditions up to 600 volts.

HEAVY DUTY LINE . . . Larger, sturdily constructed with heavier contacts, they successfully meet challenge of tough operating conditions. Ideal wherever heavy control currents must be handled with unusual frequency.

OIL TIGHT HEAVY DUTY LINE . . . When control stations are positioned on machine tools and other equipment where they will be convenient to the operator but may be sprayed or flooded with cutting oil or similar fluids, these oil tight controls are the answer.

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DESIGNING WITH ALUMINUM

NO. 9

This is one of a series of information sheets which discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series will be supplied on request. Address: Advertising Department, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

CHOOSING AN ALUMINUM CASTING ALLOY & HEAT-TREATMENT

CHOOSING the proper aluminum casting alloy and heat-treatment requires a complete knowledge of the service conditions of the part under consideration, as well as of the alloys, heat treatments, and various casting methods in common use.

There are over thirty recognized casting alloys, with as many as five different heat-treatment possibilities for some, which results in quite a formidable number of choices. From these available alloy and heat-treatment combinations the possible range of typical mechanical properties varies widely as can be seen in the following table:

TABLE 1 Range of Mechanical Properties of Cast Aluminum Alloys

Ult. Tensile Strength	19,000 to 46,000 PSI
Yield Strength	8,000 to 43,000 PSI
Elongation	Zero to 14% in 2"
Fatigue	5,500 to 23,000 PSI
Brinell Hardness	40 to 140

The physical properties likewise, vary over a broad range as shown below:

TABLE 2 Range of Some Physical Properties of Cast Aluminum Alloys

General foundry characteristics	Fair to Excellent
Susceptibility to hot-shortness	Appreciable to Very Little
Ability to be cast in thin sections	Fair to Excellent
Leak tightness	Fair to Excellent
Internal shrinkage	Considerable to Very Little
Machinability	Fair to Excellent
Weldability	Not Recomended to Excellent
Resistance to certain chemicals and compounds	Can't use to Recommended
Strength at elevated temperatures	Low to Moderate
Resistance to corrosion	Fair to Excellent
Impact, or shock-load resistance	Poor to Excellent
Thermal conductivity	.21 to .45 CGS units @ 25°C
Electrical conductivity	21 to 50% of copper (equal volume basis)
Stability to low temperature aging	Low stability to stable

Because of this wide range of properties from which to select, it is recommended that the alloy and heat-treatment be determined by the designer, rather than by the foundryman, because usually the designer has all the data which affect the choice. The foundry should be consulted, but should not be the sole judge. Other factors, each equally as important as foundry characteristics, enter into the alloy and heat-treatment selection.

The designer usually knows which property is required to the fullest extent for the part in question. This should, theoretically, make it fairly easy to select the correct combination from the tables, by merely choosing the one that has the desired property to the maximum degree. But unfortunately, castings having the desired ultimate strength for instance, may not have the required elongation or shock resistance, nor the desirable foundry characteristics. Another having the desired foundry characteristics may not have the required strength and machining properties.

Still another combination may have the required mechanical properties, foundry characteristics and corrosion resistance, but because of size and shape of casting, cannot be given the theoretically ideal heat-treatment. Compromises will have to be made in almost all cases and this can best be done by the designer. In fact, it will sometimes be necessary to actually change the design of part in order to make it adaptable for production in a given alloy and heat-treatment or to cast it by a certain process.

Factors to Consider

To enable the designer to make best alloy and heat-treat recommendations, he should be familiar with production and service requirements. He should also have a fair working knowledge of the aluminum alloys, heat treatments, and of the possibilities and limitations of the various casting processes.

The production and service requirements have a large bearing on the casting method, as do size and shape of part. For example, castings required in fairly large numbers, should be made either by permanent mold or die casting process, provided the size and design features of casting and available alloys are suitable.

Sand casting process is usually confined to producing parts required in small quantities, those having hollow cavities and complex arrangement of ribs, pockets, etc., and to those whose size makes them unsuited for casting in metal molds. In many cases it will be advantageous to redesign a part to make it adaptable for production by either permanent mold or die casting method.

Once the casting method is determined, the alloy choice is narrowed down appreciably.

Next to be considered are the service requirements. If high strength is necessary, that ordinarily eliminates the unheat-treatable alloys unless sufficient metal can be added to compensate for the lower mechanical properties. This can be further and rapidly narrowed down when the remaining requirements such as leak tightness, corrosion resistance, machinability and others are considered.

In some instances, one certain property may be required to the maximum degree—for example, highest possible yield. This immediately narrows down the alloy and heat treatment choice as well as casting method to a possible one or two, and bigger compromises will have to be made for the other requirements.

In other cases the large size and shape of casting may not permit the safe use of a "solution heat-treatment," but will limit it to use of a "straight aging treatment" taking place in approximate temperature range of 300° F to 500° F, or to no treatment at all, thereby sacrificing, to a degree, some of the mechanical properties and slightly decreasing machinability.

The reason for this limitation is the fact that the first half of a solution heat-treatment takes place at a temperature ranging between 930° F to 1,000° F, followed by rapid quench in water. At those temperatures, the mechanical strength of aluminum is practically zero and therefore certain large unsupported areas of the casting, or the whole casting at times, may sag or distort from its own weight. Sometimes the size and shape of part are such that it can withstand the effects of the high temperatures but cannot be quenched without danger of warping or cracking.

Die castings are always used in the as-cast condition, which limits the choice to one of alloy selection only.

To assist the designer in becoming familiar with the various casting processes, mechanical properties, and physical properties we refer him to these tables on the following pages:

Table #3—Typical Mechanical Properties of Aluminum Sand Castings

Table #4—Typical Mechanical Properties of Aluminum Permanent Mold Castings

Table #5—Typical Mechanical Properties of Aluminum Die Castings

Table #6—Alloy selection Guide

PLEASE TURN TO NEXT PAGE ➡

PERMANENT MOLD CASTING ALLOYS—TABLE 4

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Percent in 2"	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	23,000	9,000	10.0	45	.....	E	E	VL	E	F	E	VG
A108	AC	28,000	16,000	2.0	70	.....	E	G	MIN	VG	G	G	G
	AC	28,000	19,000	2.0	70	.....	F	G	MOD	F	G	F	F
	AC	30,000	24,000	1.0	80	9,500	G	VG	VL	G	G	G	G
122	T52	35,000	31,000	1.0	100	.....	G	G	MOD	G	E	F	F
122	T551	37,000	35,000	.....	115	8,500	G	G	MOD	G	E	F	F
122	T65	45,000	36,000	.....	140	9,000	G	G	MOD	G	E	F	F
A132	T551	36,000	28,000	.5	105	13,500	F	VG	VL	F	F	G	G
A132	T65	47,000	43,000	.5	125	.....	F	VG	VL	F	F	G	G
D132	T5	36,000	28,000	1.0	105	13,500	G	VG	MIN	G	F	G	G
138	AC	30,000	24,000	1.5	100	.....					G		
142	T571	40,000	34,000	1.0	105	10,500	F	F	AP	F	VG	G	F
142	T61	47,000	42,000	.5	110	9,500	F	F	AP	F	VG	G	F
B195	T4[4]	37,000	19,000	9.0	75	9,500	F	F	MOD	F	G	G	G
B195	T6	40,000	26,000	5.0	90	10,000	F	F	MOD	F	G	G	G
B195	T7	39,000	20,000	4.5	80	9,000	F	F	MOD	F	G	G	G
A214	AC	27,000	16,000	7.0	60	.....	F	F	AP	F	E	E	G
	AC	34,000	19,000	2.5	85	.....	G	G	VL	G	G	G	G
	T6	40,000	27,000	3.0	95	.....	G	G	VL	G	G	G	G
	AC	34,000	19,000	2.0	90	14,500	G	G	VL	G	F	G	G
	T5	34,000	25,000	1.0	100	12,000	G	G	VL	G	F	G	G
	T6	42,000	30,000	1.5	105	15,000	G	G	VL	G	F	G	G
	T7	37,000	28,000	2.0	90	12,000	G	G	VL	G	F	G	G
355	T51	30,000	24,000	2.0	75	.....	E	E	VL	E	VG	VG	VG
355	T6	43,000	27,000	4.0	90	10,000	E	E	VL	E	VG	VG	VG
355	T62	45,000	40,000	1.5	105	10,000	E	E	VL	E	E	VG	VG
355	T7	40,000	30,000	2.0	85	10,000	E	E	VL	E	VG	VG	VG
355	T71	36,000	31,000	3.0	85	10,000	E	E	VL	E	VG	VG	VG
356	T6	40,000	27,000	5.0	90	13,000	E	E	VL	E	G	E	VG
356	T7	33,000	24,000	5.0	70	11,000	E	E	VL	E	G	E	VG
363	AC	35,000	23,000	2.7	85	.....	E	VG	VL	E	E	G	E
363	T6	48,000	28,000	6.5	90	.....	E	VG	VL	E	E	VG	E

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—applies to Hot-Shortness only.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.

SAND CASTING ALLOYS—TABLE 3

Alloy	H. T.[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]						
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinnell 10/500	Fatigue psi	Feeding Ability	Pressure Tightness	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability[5]
43	AC	19,000	8,000	8.0	40	6,500	E	E	VL	E	F	E	VG
	AC	21,000	14,000	2.5	55	8,000	E	E	MIN	VG	G	G	G
	AC	24,000	15,000	1.5	70	9,000	F	F	MOD	G	G	G	F
	AC	24,000	15,000	1.5	70	9,000	G	G	MOD	G	G	G	G
122	T2	27,000	20,000	1.0	80	9,500	G	VG	MOD	G	E	F	F
122	T61	41,000	40,000	(6)	115	8,500	G	VG	MOD	G	E	F	F
142	T21	27,000	18,000	1.0	70	6,500	G	F	AP	F	G	G	F
142	T571	32,000	28,000	.5	85	8,000	G	F	AP	F	G	G	F
142	T77	28,000	25,000	2.0	75	9,500	G	F	AP	F	G	G	F
195	T4[4]	32,000	16,000	8.5	60	6,000	G	G	AP	F	G	G	F
195	T6	36,000	24,000	5.0	75	6,500	G	G	AP	F	VG	G	F
195	T62	40,000	30,000	2.0	90	7,000	G	G	AP	F	E	G	F
212	AC	23,000	14,000	2.0	65	8,000	G	G	MOD	G	E	G	G
214	AC	25,000	12,000	9.0	50	5,500	F	F	MOD	F	E	E	G
B214	AC	20,000	13,000	2.0	50	.....	G	F	MOD	F	E	E	G
F214	AC	21,000	12,000	3.0	50	.....	G	F	MOD	F	E	E	G
220	T4	46,000	25,000	14.0	75	7,000	F	F	MOD	F	E	E	G
319	AC	27,000	18,000	2.0	70	10,000	G	E	VL	VG	G	G	G
319	T6	36,000	24,000	2.0	80	10,000	G	E	VL	VG	G	G	G
355	T51	28,000	23,000	1.5	65	7,000	E	E	VL	E	E	VG	VG
355	T6	35,000	25,000	2.5	80	8,500	E	E	VL	E	E	VG	VG
355	T61	39,000	35,000	1.0	90	.....	E	E	VL	E	E	VG	VG
355	T7	38,000	36,000	0.5	85	8,500	E	E	VL	E	E	VG	VG
355	T71	35,000	29,000	1.5	75	10,000	E	E	VL	E	G	VG	VG
356	T51	25,000	20,000	2.0	60	7,500	E	E	VL	E	G	E	VG
356	T6	33,000	24,000	4.0	70	8,000	E	E	VL	E	G	E	VG
356	T7	34,000	30,000	2.0	75	.....	E	E	VL	E	E	E	VG
356	T71	28,000	21,000	4.5	60	.....	E	E	VL	E	G	E	VG

NOTES:

1. Properties determined on standard tensile test bars cast under favorable conditions and properly heat-treated, when applicable.
2. Ratings: E, excellent; VG, very good; G, good; F, fair—apply to all castings and service characteristics except Hot-Shortness; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—applies to Hot-Shortness only.
3. AC, as cast.
4. On standing at room temperature for several weeks, properties approach those of T6 condition.
5. Weld before heat-treating, using appropriate filler rod.
6. Less than 0.5% elongation.

DIE CASTING ALLOYS—TABLE 5

Alloy	Condition[3]	Typical Mechanical Properties[1]					Casting and Service Characteristics[2]					
		Tensile Strength psi	Yield Strength psi	Elongation Per Cent in 2"	Hardness Brinnell 10/500	Fatigue psi	Mold Filling Capacity	Hot-Shortness	General Castability	Machinability	Corrosion Resistance	Weldability
13	AC	39,000	21,000	2.0	---	19,000	VG	VL	VG	F	VG	not
A 13	AC	35,000	16,000	3.5	---	.....	VG	VL	VG	F	VG	recom-
43	AC	30,000	16,000	9.0	---	17,000	G	MIN	G	F	VG	mended
85	AC	40,000	24,000	5.0	---	22,000	G	MOD	G	F	VG	"
218	AC	45,000	27,000	8.0	---	23,000	F	AP	F	E	E	"
360	AC	44,000	27,000	3.0	---	19,000	E	VL	E	F	G	"
A360[4]	AC	41,000	23,000	5.0	---	18,000	E	VL	G	F	E	"
	AC	45,000	26,000	2.0	---	20,000	VG	MOD	G	G	G	"
	AC	46,000	25,000	3.0	---	19,000	VG	MOD	G	G	G	"
	AC	46,000	27,000	1.0	---	21,000	VG	MOD	G	F	G	"

NOTES:

1. Properties determined from standard test bars cast under favorable conditions.
2. Ratings: E, excellent; VG, very good; F, fair—apply to all castings and service characteristics except "hot-shortness"; MOD, moderate; VL, very little; AP, appreciable; MIN, minor—apply to "hot-shortness" only.
3. As cast.
4. In A360 and A380, the iron content is controlled more closely than in 360 and 380 alloys.

SELECTION GUIDE—TABLE 6

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
General purpose—Low strength arranged in order of decreasing castability	43 108 212 214	43 A108 A214	43 A 13 13
General purpose—Heat-treated[1] good balance of all properties for most applications	355-T6 356-T6 19-ST6	355-T6 356-T6 B19-ST6	380 A380 360 A360
Best castability for complex castings with thin sections—arranged in order of decreasing castability	43 108 356 355	43 A108 356 355	A360; 360 A 13; 13 43
High ductility and **shock resistance** arranged in order of decreasing properties	220-T4 195-T4 356-T6 214[2] 43	363-T6 B195-T4 356-T6 A214 43	218 A360 43
Pressure tight—Low stressed	43 108	43 A108	A360 A 13 43
Pressure tight—High stressed	356 355	356 355 363	A360

Major Property Wanted	Sand Cast	Perm. Mold	Die Cast
Corrosion Resistance	43 214 220 356 355	43 A214 356 355 363	218 A360
Ornamental and Architectural Applications—also food handling, dairy equipment, cooking utensils and marine fittings	43 214[2] B214[2] F214[2]	43 A214[2]	43 218[2]
Piston Alloys—good properties at operating temperatures	122 142	122 A132 D132 142	384
Other alloys having good properties at moderate temperatures	214	138 A214	13 360
Good machinability—Heat-treated castings machine better than those in as-cast condition, and generally those having highest hardness machine better than the softer ones in any one alloy	122 212 214 B214 F214 220-T4 195	122 355 363 A214 A108	218 A380

NOTES:

1. Except die castings.
2. These alloys take anodized finish without appreciable discoloration.

More detailed assistance with design, alloy selection, fabrication, and heat-treatment procedure is obtainable through any Kaiser Aluminum sales office located in principal cities, or write to Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

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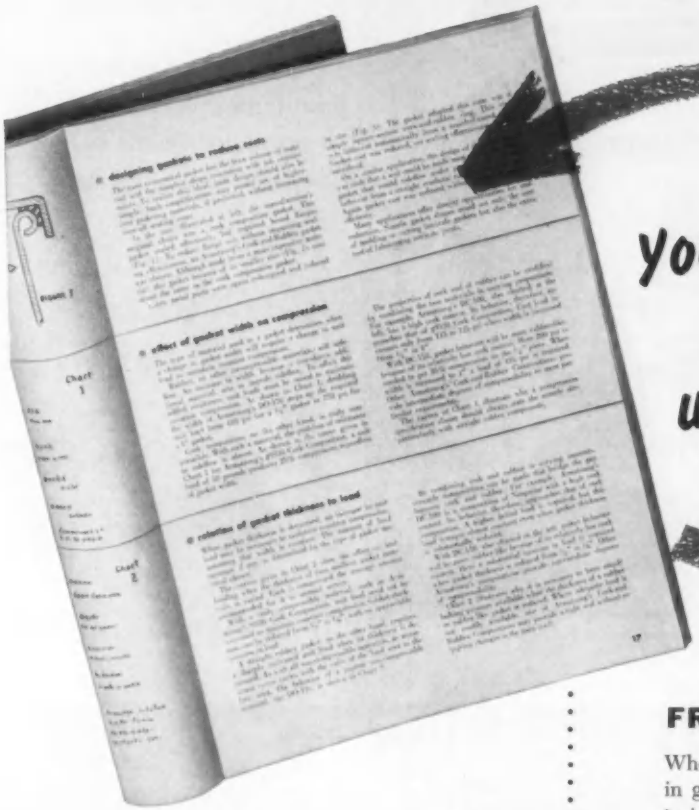

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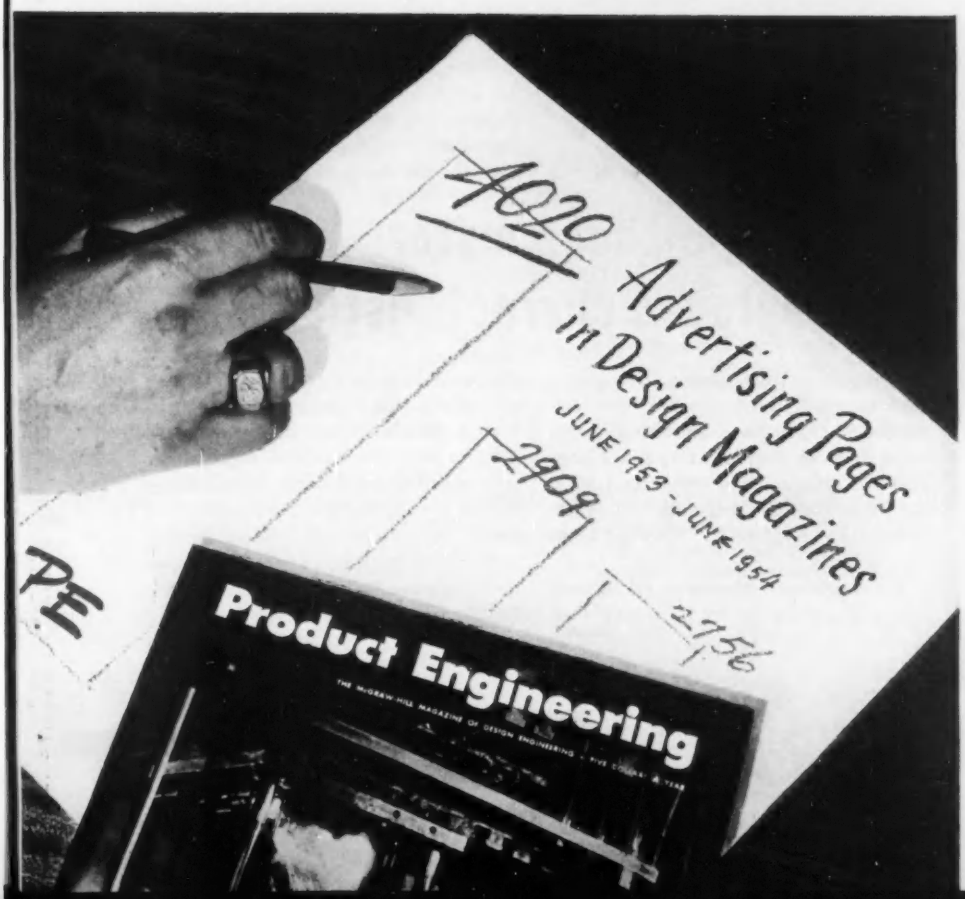

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1½	K182 220/440 v* 550 v	208 v K184 220/440 v* 550 v	K184 220/440 v* 550 v	K213 220/440 v*
2	K184 220/440 v* 550 v	208 v K184 220/440 v* 550 v	K213 220/440 v* 550 v	K215 220/440 v*
3	K184 220/440 v* 550 v	208 v K213 220/440 v* 550 v	K215 220/440 v*	208 v* K254U 220/440 v* 550 v*
5	K213 220/440 v*	K215 208 v 220/440 v*	208 v* K254U 220/440 v* 550 v*	208 v* K256U 220/440 v* 550 v*
7½	K215 220/440 v*	208 v* K254U 220/440 v* 550 v*	208 v* K256U 220/440 v* 550 v*	
10	208 v* K254U 220/440 v* 550 v*	208 v* K256U 220/440 v* 550 v*		

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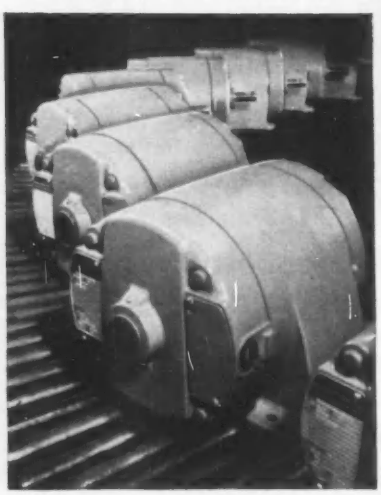

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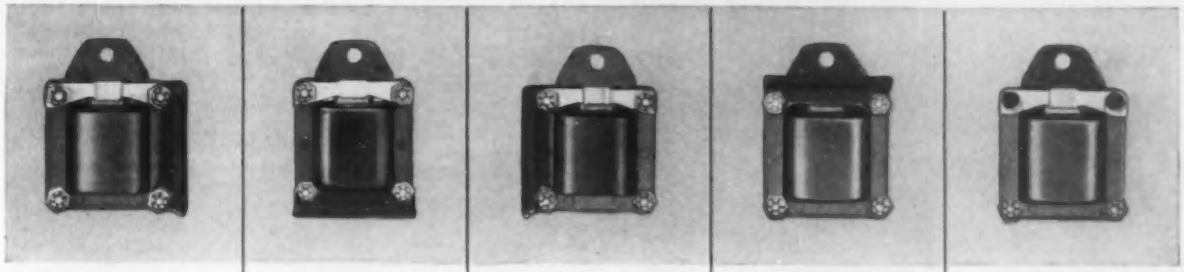

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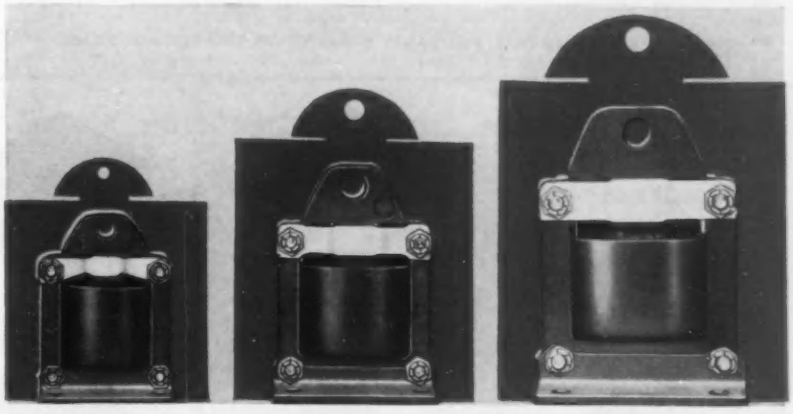

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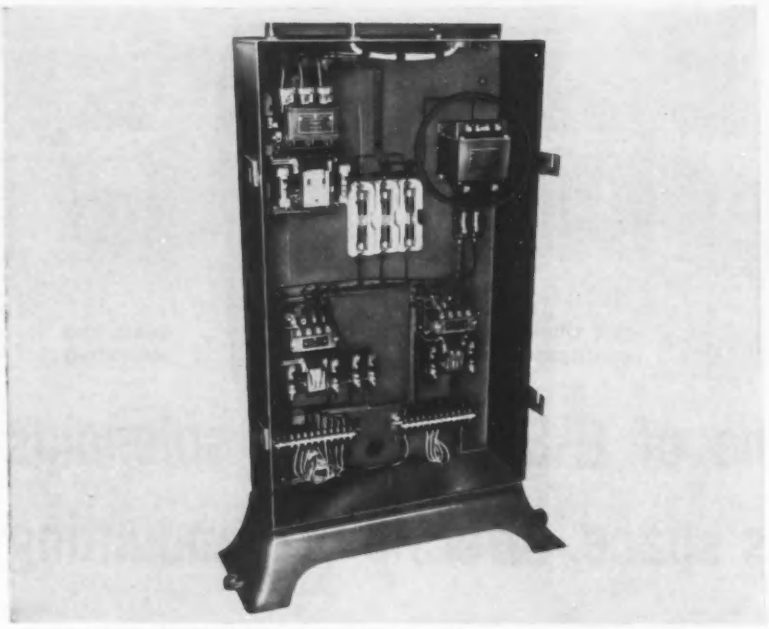

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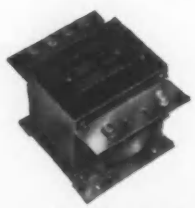
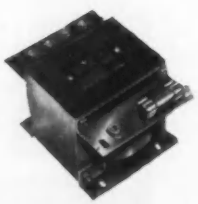
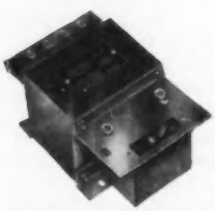
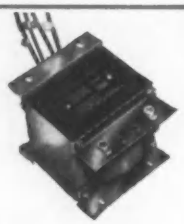
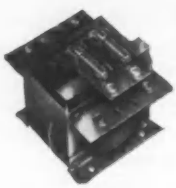
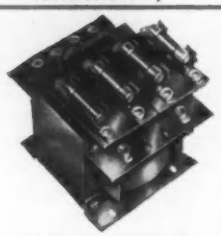
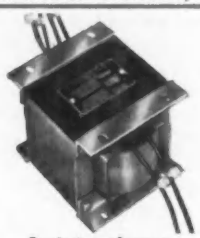
Basic standard transformer ratings are available with fuses or circuit breakers, with or without terminal boards, in the new line of G-E transformers, thus enabling you to give your customer exactly the transformer he requires—in effect "special" units at stock item prices.

All electrical requirements of NEMA and JIC are met by these space-saving units. Built specifically for machine-tool operation, ease of mounting helps reduce installation cost, and low price helps you keep over-all equipment costs down.

The wide rating range of these new units covers one hundred different machine-tool transformers. There are eight volt-ampere ratings: 50 to 1500 va. Two frequency and primary voltage combinations are available: 60 cycles, 230/460 volts, and 50/60 cycles, 230/460/575 volts. Two secondary voltage combinations offered are 60 cycles, 115 volts for domestic use, and 50/60 cycles, 115/95 volts for domestic or import use. There are five construction combinations, 50 to 150 va, and seven more, 300 to 1500 va. For information and specifications, write for Bulletin GEC-1270.

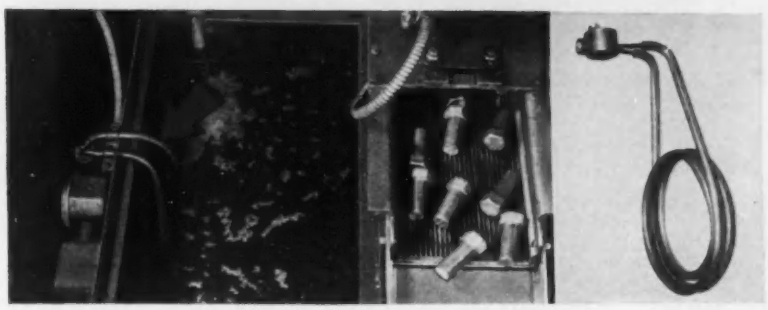
SELECT FROM SEVEN ACCESSORY GROUPS— OFFER CUSTOMERS A "SPECIAL" UNIT AT A STOCK PRICE	 Basic transformer with terminal boards	 With terminal boards; fused secondary	 With terminal boards; circuit breaker in secondary
 With secondary terminal boards; primary leads out	 With terminal boards and 2-fuse board	 With terminal boards and 4-fuse board	 Basic transformer (leads out)

GENERAL ELECTRIC

Designer's Digest

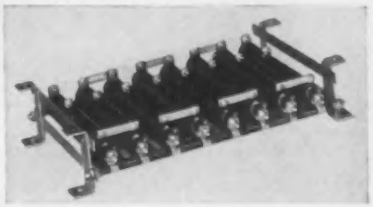
PRODUCT HIGHLIGHTS

Versatile Calrod* heaters offer low-cost, uniform heat for any size or shape product



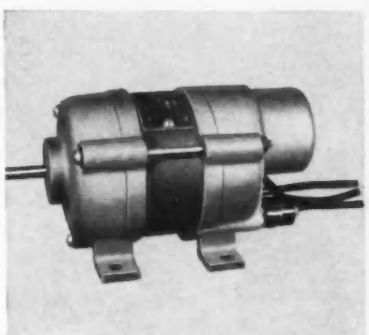
If you use heat on your machines, investigate G-E Calrod heaters. One machine manufacturer, for example, locates a Calrod over-the-side immersion heater in a cleaning solution at the discharge end of a bolt-making machine, (shown above). Bolts coming from the machine are cleaned of oil, grease, and dirt at much lower cost than former cleaning methods. Installing a "spot" or "zone" of heat into your machines is simple and inexpensive with Calrod heaters. Write for Bulletin GEA-5886.

*Registered Trade-mark of General Electric Company



G.E.'s space-saving resistors reduce storage, handling costs

Sturdy, lightweight G-E resistors provide space economy and meet special design requirements. There are three types: smoothwound to give high resistance with low current ratings; open-wound wire, for applications with intermediate needs; edgewise wound ribbon, for low resistance in high current circuits. Extremely versatile, they are offered in 3, 6, 9, 12 and 15 inch lengths. Units of same length can be combined in one mounting frame. Use them for difficult mountings, long life and smooth operation. See Bulletin GEA-4527.



G-E selsyns provide automatic synchronized motion control

Use these economical, low-maintenance G-E selsyns to interconnect two or more remote points of a system. They provide accurate, automatic, synchronized indication or control, and can be designed into an extremely wide variety of machines and systems. Use them for indicating positions, for signaling systems, for automatic or remote control, or for recording changes instantaneously and dependably. Selsyns are rugged and compact. Simple in construction, selsyns require no complicated adjustments and their sturdy parts help assure long, dependable operation. Bulletin GEA-2176.

New G-E curved-surface roughness scales help cut rejects

To help measure roughness of internal or external surfaces, General Electric announces a new set of scales with cylindrical surfaces that provide standards of comparison by sight and touch. The scales offer a quick, convenient, low-cost method for the machinist and inspector to check roughness specifications selected by the designer. Time is saved and guesswork ended. One scale has values from 4 to 63 microinches, produced commonly by grinding, honing and superfinishing. The other has values from 16 to 250 microinches, obtained usually on lathe and screw machines in turning and boring. Write for Bulletin GEC-774.

General Electric Co., Apparatus Sales Division, Sec. A668-119, Schenectady, N.Y.

Please send me the following bulletins: √ for reference X for immediate project

- ☐ GEC-1270 New Machine Tool Transformers
- ☐ GEA-5886 Calrod Electric Heaters
- ☐ GEC-774 Surface Roughness Scales
- ☐ GEA-2176 Selsyns
- ☐ GEA-4527 Resistors

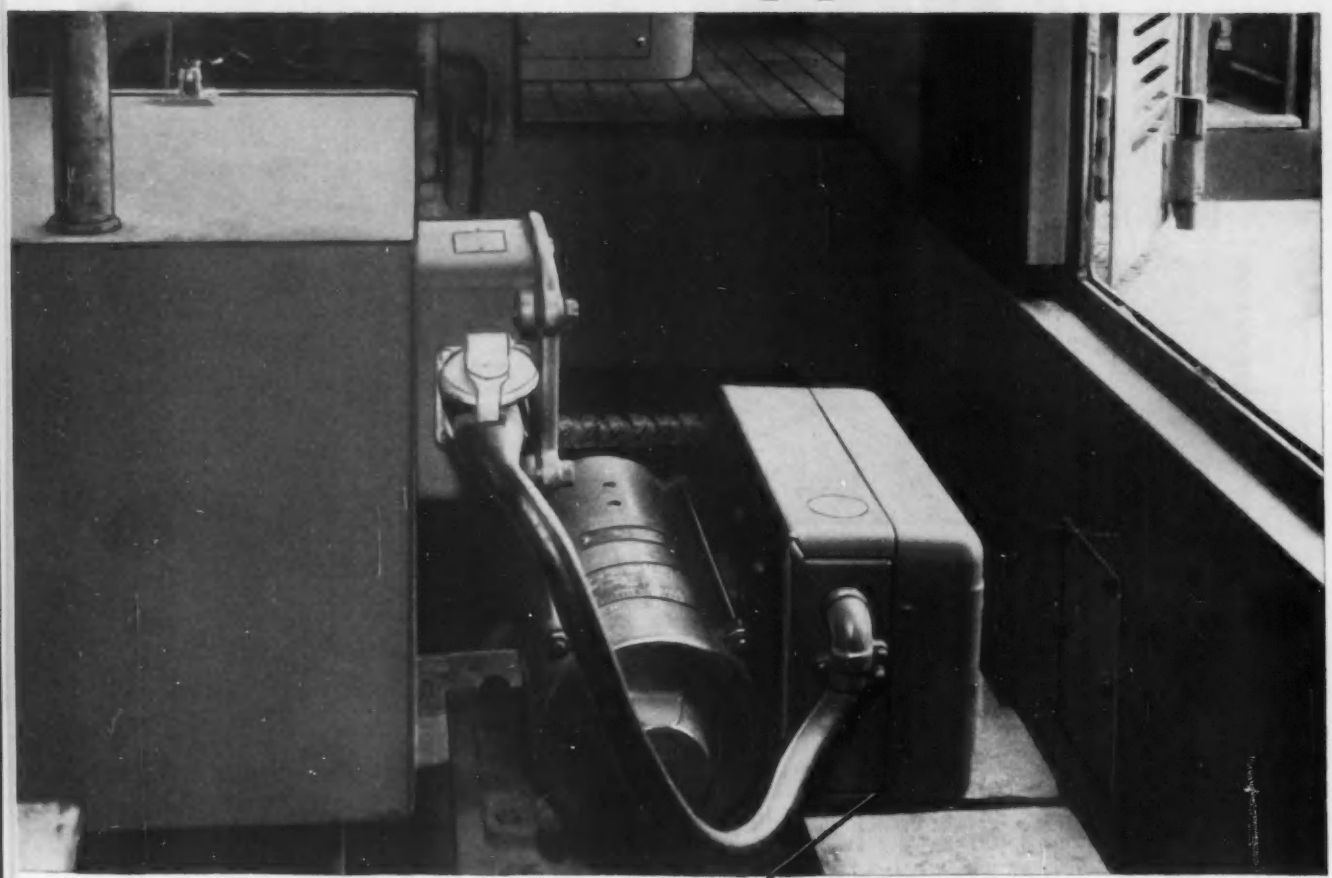
CONSULT YOUR SWEET'S PRODUCT DESIGN FILE. You'll find everything electric for machinery manufacturers in the General Electric Section.

NAME ..... COMPANY .....

CITY ..... STATE .....

The Erie Railroad story shows why it pays to . . .

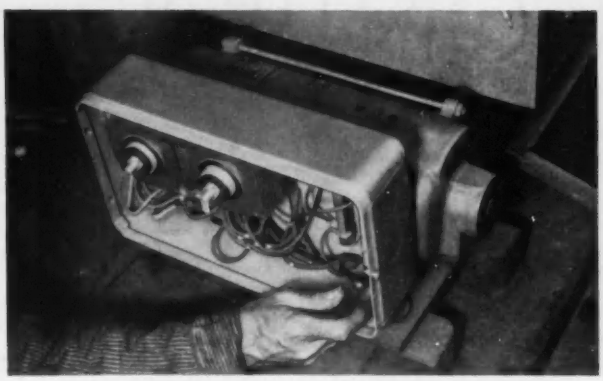
Get motor application



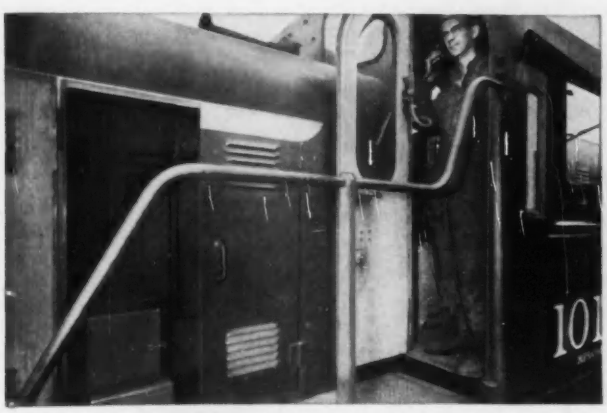
THE ERIE RAILROAD REQUIRED motor alternators to provide 115-volt, 60-cycle power for communication equipment between diesel-electric engines, cabooses, and control stations. The railroad had been using a 64-volt battery system. Illustrations (above) show the G-E designed motor alternator—chosen after competitive tests—and location in the engine. At right, is a brief story of how G-E engineers met the rigid specifications and solved the Erie Railroad's particular problem.

help from G-E Engineers

PROBLEM WAS PRESENTED to G-E sales engineer. Erie Railroad required maintenance-free operation for 3 month periods and a design that would make all servicing feasible except rewinding.



G-E ENGINEERS at the Specialty Component Motor Department in Fort Wayne, Indiana, designed a special open construction type of motor alternator to meet the railroad's precise specifications.



RUGGED TESTS were given this G-E motor alternator on a switcher in railroad's Marion, Ohio, yard. The design struck a happy medium as to design and service, now used on 75 passenger and yard diesels.

PROBLEMS of motor design and motor application are being solved daily at General Electric's Specialty Component Motor Department in Fort Wayne, Indiana. The accumulated engineering experience—unmatched anywhere—starts working for you when you bring your tough motor application problems to General Electric.

THE ERIE RAILROAD had the problem of providing a dependable power supply for their communications equipment mounted on diesel-electric passenger locomotives, switchers and cabooses. They established their needs as a motor-alternator set supplying 115-volt, 60-cycle current. Close voltage control was necessary to insure satisfactory radio tube operation.

WITH THESE REQUIREMENTS in mind, General Electric designed a 2-unit 2-bearing motor alternator which proved the merit and effectiveness of G-E application help in rugged competitive tests.

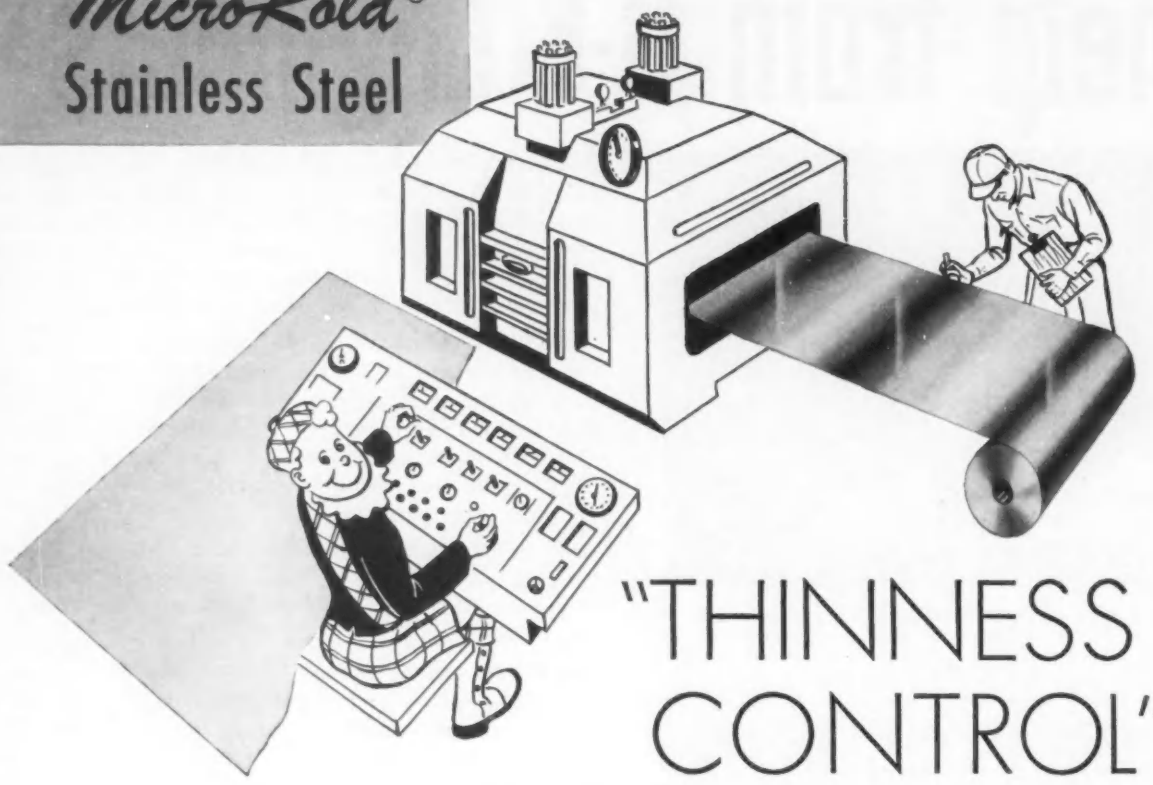
WHEN YOU HAVE a tough motor application problem, take it to General Electric. Take advantage of G-E engineering skill and talent backed by years of experience. Contact your nearby General Electric Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y. 704-21

Progress Is Our Most Important Product

GENERAL ELECTRIC

APPLICATION HELP provided by G-E engineers in solving the Erie Railroad's problem typifies the many cases where design engineers have found it pays to take motor application problems to G.E.

MicroRold® Stainless Steel



"THINNESS CONTROL"

provides strip *Quality* in SHEET *Sizes*

Remarkable uniformity of gauge in MicroRold Stainless Sheets up to 36″ wide.

The "Thinness Control" used in the manufacture of light gauge MicroRold Stainless Sheets assures you of the *same* dimensional accuracy as in strip stainless. Specified gauge thicknesses may be rolled in sheet sizes with tolerances as low as 3% average (plus or minus) as compared to the A.I.S.I. allowable of plus or minus 10%. This results not only in weight savings but also in fabricating economies.

With "Thinness Control" MicroRold's close adherence to a specified gauge will naturally result in a longer die life. Not only is MicroRold held closely to the specified thickness, but the "crown", or extra thickness in the center, is less in MicroRold than the "crown" in sheets rolled by conventional practice.

Regular use of MicroRold Sheet can give you more stainless area per ton or the equivalent area with lesser weight.

MicroRold Stainless Steel Sheets are available up to 36" wide and in gauges from .005 in commercial grades, finishes and temper.

Ask your steel warehouse distributor for MicroRold with "Thinness Control"

Washington Steel *Corporation*

Washington, Pennsylvania

Perspectives

DESIGN AND DEVELOPMENT

WASHINGTON'S NEW LOOK

The area around Washington, D. C. is taking on a new look as more and more companies realize that it pays to be near the source of supply—the source of supply in this case being the $3-billion which will be spent this year by the various government agencies for research and development projects.

Since the war, at least 40 companies have set up plants in or near Washington—some for research and development or pilot production, and others with complete production facilities. Included in this group are many electronics firms, and others in the guided missiles, metallurgical, fuels, chemistry and plastics, instruments, metalworking, tool and die, and acoustics fields. With these facilities, plus the engineering talent to go along, the companies are finding that they can keep a much closer contact with the sponsoring agency as the project goes along. Now it's a case of being 30 minutes from the Pentagon, instead of three or four days by train.

OTHER ADVANTAGES

Besides being close to the source of business, companies find that Washington offers other advantages. The engineering and scientific organizations and laboratories there are an excellent source of ideas for a company's staff. For example, in or near the District of Columbia are: headquarters for the Atomic Energy Commission; the National Bureau of Standards; National Advisory Committee for Aeronautics; Naval Research Laboratory; Naval Ordnance Laboratory; National Academy of Sciences; National Science Foundation; American Chemical Society; the Patent Office; Carnegie Institute Laboratories; National Institute of Health Laboratories; the Library of Congress; and many others.

Also in the company's favor, is the great supply of scientific and engineering talent from which they might choose. Most of the government agencies are staffed with men who are thoroughly familiar with almost every branch of science and industry in the nation. Every year the Military branch retires, at a comparatively young age, a number of experts in most of the industrial fields that have been supplying the arms and equipment.

NEWCOMERS

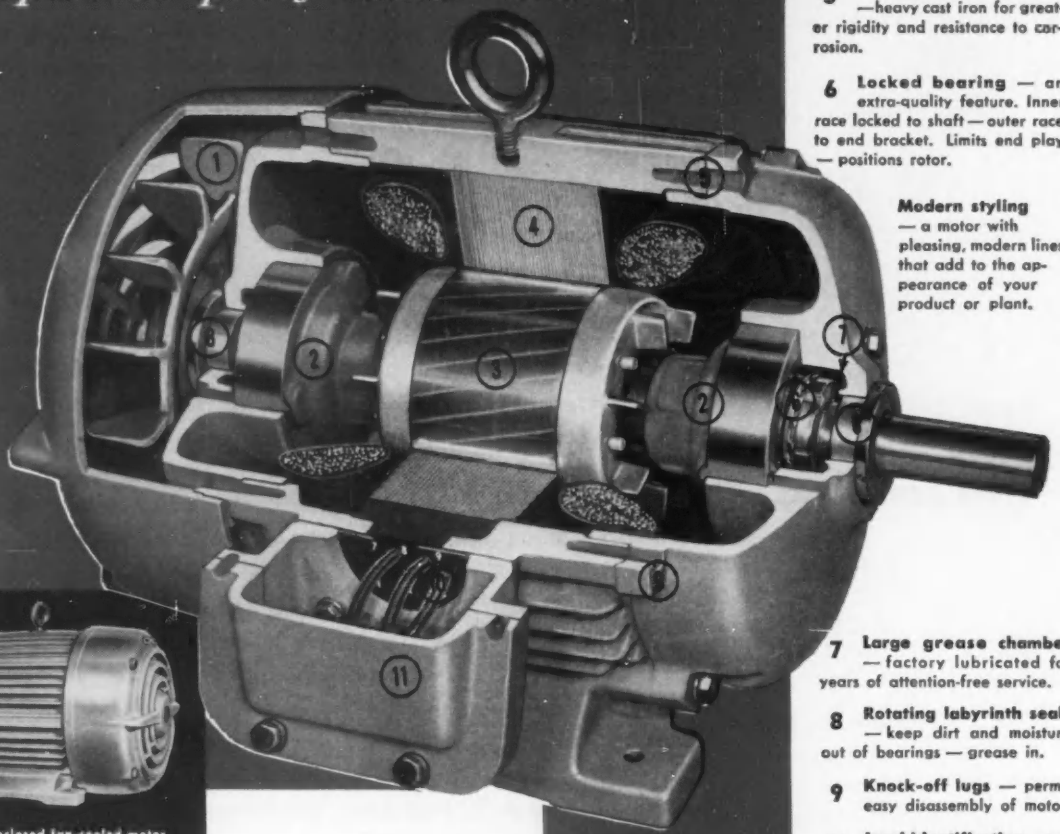
One of the latest arrivals to the Washington Area is the Electronics Division of American Car and Foundry (ACF). This plant began operations in Jan. 1954 at Alexandria, Virginia, which is just across the Potomac River from Washington. Mr. J. G. Reed, Manager of this division feels that Washington is the greatest center of research and development in

(Continued on page 125)

Here's the inside story of

the NEW L.A. *Line*

...your BEST enclosed and explosion-proof motor BUY



1 Fan — efficient, non-sparking fan. New aerodynamic design for more effective cooling.

2 Inner bearing cartridges — lock bearings to end bracket and form explosion-quenching seal along shaft.

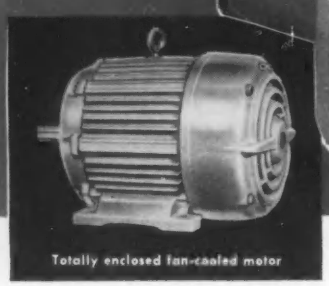
3 Indestructable cast-aluminum rotor—dynamically balanced with fan for smooth, quiet operation.

4 Stator — prewound stator core utilizes Formvar wire insulated with a new Alkyd Asphalt Resin insulating varnish.

5 End bracket and housing —heavy cast iron for greater rigidity and resistance to corrosion.

6 Locked bearing — an extra-quality feature. Inner race locked to shaft — outer race to end bracket. Limits end play — positions rotor.

Modern styling — a motor with pleasing, modern lines that add to the appearance of your product or plant.



Totally enclosed fan-cooled motor

Cutaway view of explosion-proof motor

7 Large grease chamber — factory lubricated for years of attention-free service.

8 Rotating labyrinth seals — keep dirt and moisture out of bearings — grease in.

9 Knock-off lugs — permit easy disassembly of motor.

10 Lead identification—permanent, positive lead identification spacer in conduit box.

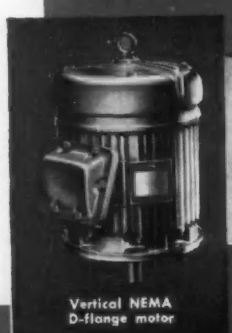
11 New split conduit box — rugged cast-iron conduit box diagonally split for easy connection.

This is the completely new L.A. totally enclosed fan-cooled and explosion-proof motor. Every feature in this new line is designed for easier installation, longer service life, less maintenance and attention. You get the full benefit of the new NEMA standards in a smaller, more functional, completely modern design.

Your nearby Louis Allis Sales Engineer can show you all the reasons why these motors perform better and longer on your tough jobs — why they give you maximum resistance to corrosion wherever you need this extra protection. Call him today.

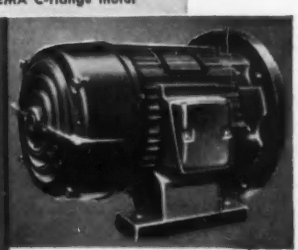
THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

LA-103



Vertical NEMA D-flange motor

NEMA C-flange motor



NEMA D-flange motor

We specialize in SPECIAL MOTORS — *and* PROMPT DELIVERY, TOO

There's a Louis Allis special motor for your toughest application. Whatever electrical or mechanical modifications you need, check first with Louis Allis.

the world. He reasons that people working in the science and technology fields prefer to work in an environment in which there are many fellow scientists and engineers. Washington is such a place. Consequently, the problem of getting, and keeping these people is greatly simplified under these circumstances. Reed says, "It stimulates the productivity of the technical individual. And we are now confronted with the fact that the lines of demarcation between the various fields in science are fading. One field overlaps another, and oftentimes several others. This means that progress will become more dependent upon the availability of specialized knowledge in fields other than the principal one with which the company is immediately concerned."

Melpar, Inc., a firm which less than ten years ago began electronics research for the Navy and Air Force, has expanded more than a 100 percent since then. Having merged with Westinghouse Airbrake, they are now completing a $10-million research plant in Virginia less than ten minutes from the Pentagon. Melpar's headquarters in Alexandria, Va., are less than five minutes from the Pentagon and the Navy department.

Another is the Atlantic Research Corporation. Only five years in the electronics field, it has contracts from the Navy and Air Force totaling more than $1-million.

There are many others too, such as: Emerson Electric; Geophysical Instruments; Timber Engineering Co.; Engineering and Research Corp.; Reed Research; Jacob Instrument Co.; and Intelligent Machines Research Corporation.

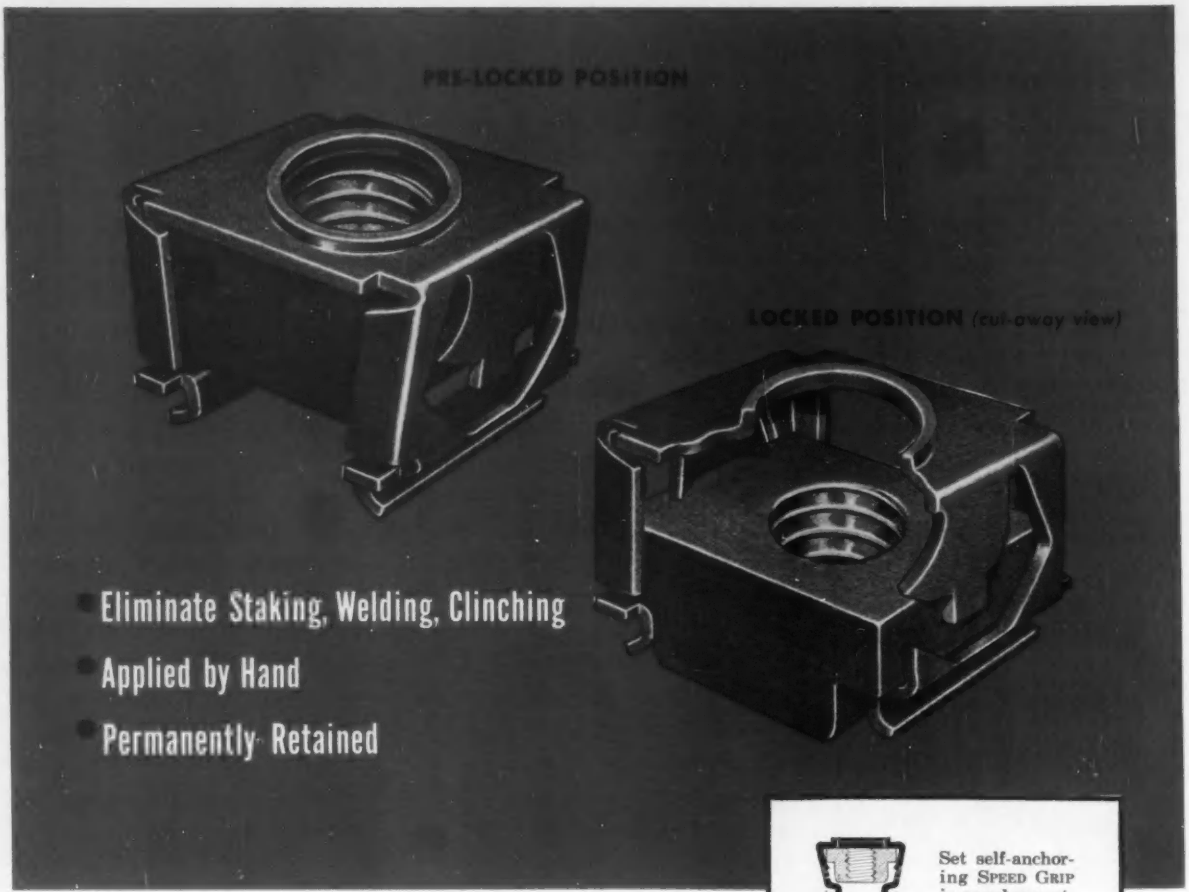
THE BIG ONES

Besides these there are the large engineering staffs of corporations like General Motors; General Electric; Westinghouse Electric; Douglas Aircraft; Boeing; Consolidated Vultee; and others. Consolidated Vultee Aircraft, Div. of General Dynamics Corp., for example, maintains a Washington engineering staff capable of handling any problem which may come up concerning any of its many aircraft, guided missile, and electronic projects. Moreover, company experts in specific fields, about 25 a week, are becoming as familiar with Washington government research and procurement agencies, as they are with their home plant across the country.

General Electric has a permanent Washington staff of more than 200. In addition to this group, each day an average of 20 research technical and management experts check in at the Washington offices while on their way to conferences in the Pentagon, at ARDC in Baltimore, at the Naval Research Laboratories, and with the many government agencies.

MORE COMPETITION

With competition for these government contracts becoming keener as the threat of war lessens, more emphasis is being placed on the research and development of better weapons and equipment, rather than on production. A company with an engineering staff in Washington can take any problems directly to the government agency for clarification.

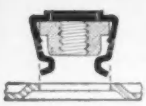


New, Self-Anchoring SPEED GRIP®

cuts assembly costs in half!

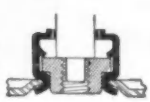
Whatever your present method of attaching square nuts to panels, new self-anchoring SPEED GRIPS can do the job faster, easier, better. This unique fastener has spring steel "mechanical hands" that permanently lock the nut in bolt-receiving position. It cannot be dislodged even with rough handling. Applied after painting or porcelainizing, there is no clogging, retapping or masking of threads to bother about. *And* it is ideal for blind location attachments.

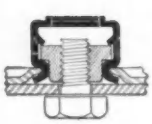
Total up the savings in application time—in expensive assembly equipment—in handling time—in assembly steps—and you'll switch to self-anchoring SPEED GRIPS—the newest addition to the complete Tinnerman line of Nut Retainers.



Set self-anchoring SPEED GRIP in panel mounting hole.

Simple tool presses nut into locked position.





Heavy duty nut in locked position — permanently retained — can't rotate, rattle or be dislodged.

Write today for free copy of new detailed SPEED GRIP Bulletin, No. 335. Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S.A., 7 rue Henri Barbusse, Levallois (Seine).

Grade Schools and Leadership

For many years Europe was the main source of new knowledge. Today pure science research is almost at a standstill in Europe. Two wars plus major social and economic disturbances put an end to many of the great laboratories. The atmosphere of Europe has not been conducive to the type of thinking and living that breeds new discoveries in physics, chemistry and mathematics. No longer can American engineers depend on England and Germany for new scientific knowledge.

At present, research in Germany is at an extremely low point. There are few scientists. That country will probably revive her schools and laboratories and rebuild her lost position, but it will take years to do it. England likewise has lost much of her capacity for research.

Today there are two nations that are striving strenuously to build sources of new knowledge—Russia and the United States of America. Little is known concerning Russia. But the records show that the United States has been making rapid progress, helped considerably by scientists who migrated from Europe. It is a splendid beginning. Whether or not the American citizens will support a comprehensive program of education to assure the continuance and growth of these beginnings appears to be doubtful.

It is a matter of record that the people in American communities have voted overwhelmingly in favor of spending millions for automobile roads, but have refused to authorize bond issues for sorely needed new schools. Millions have been budgeted for parks and playgrounds but little or nothing for increased salaries for teachers. Money is quickly budgeted for atheletic fields and music auditoriums but little or nothing for school laboratories.

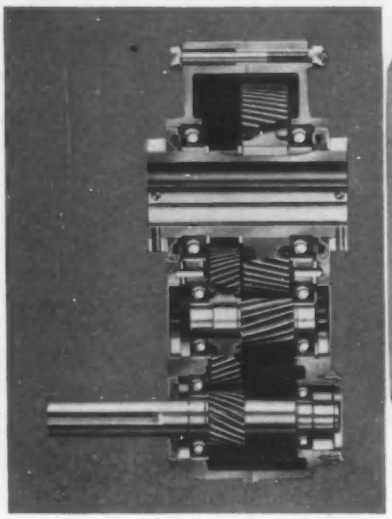
Education begins at the public school level. Qualified teachers of high school sciences and math are almost unobtainable because of the low salaries. For the same reason many of the men teachers are leaving their jobs. The quality of the high school preparation for entrance to engineering schools has been declining steadily.

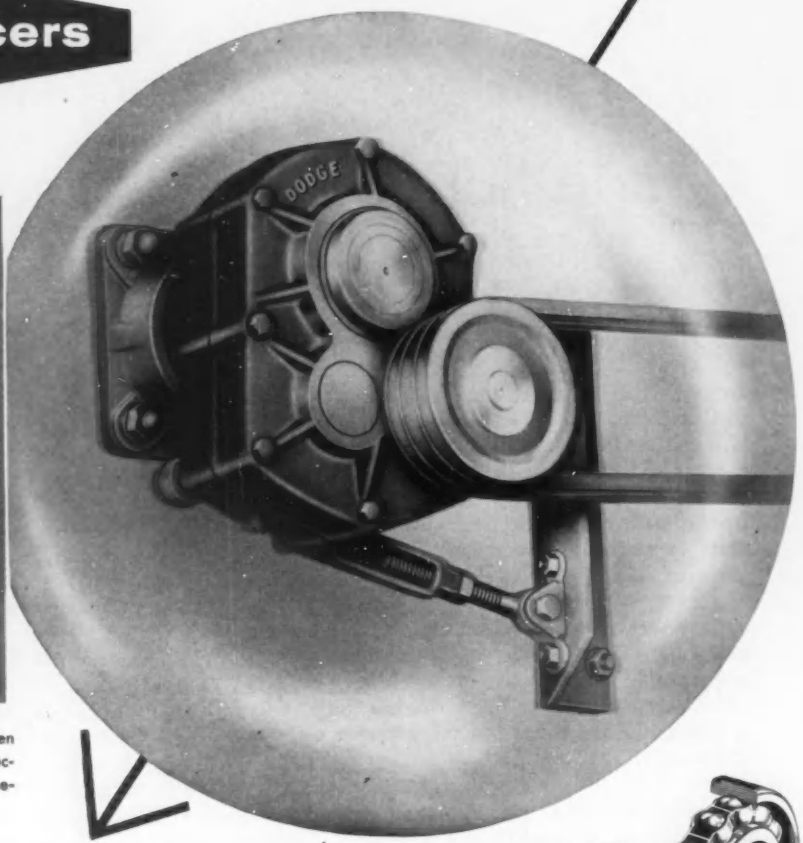
There can not be developed a sufficient supply of scientists and engineers of required stature without a public school system that gives high grade courses in sciences and mathematics. And without leadership in science and engineering, no nation will be able to hold a front line position in the coming Atomic Age.

Russia is known to be sacrificing tremendously to build her scientific manpower, research laboratories and engineering departments. Her success in this direction has been demonstrated by her ability to keep pace with the atomic energy developments in the United States. Will the American citizens sacrifice what may be required in order to develop engineers and scientific manpower? Shall America continue to hold its position of leadership?

George F. Bodenhott

Reducing Costs in Speed Reducers





New Departure ball bearings are used in seven basic sizes of the Dodge single and double reduction speed reducers, handling from 1 to 43 horsepower at output speeds from 12 to 330 r.p.m.

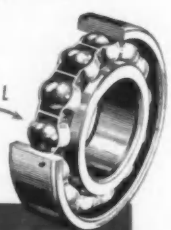
. . . with NEW DEPARTURES

Dodge Manufacturing Corporation's Speed Reducers make good use of design advantages offered by New Departure snap-ring **ball** bearings.

The snap rings locate the bearings in the case, eliminating the need for adjustment. Doing away with threaded or shim-type devices permits straight-through boring of the housing. Thus split-case construction is highly practical, and assembly is greatly simplified. The result is a rigid, highly efficient unit, and one in which production costs have been kept to the minimum.

Learn what New Departure can do for *your* product. Talk with your New Departure sales engineer—*today!*

NOTHING ROLLS LIKE A BALL



NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Plants also in Meriden, Connecticut, and Sandusky, Ohio
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Titanium Forgings

E. A. FENTZLAFF
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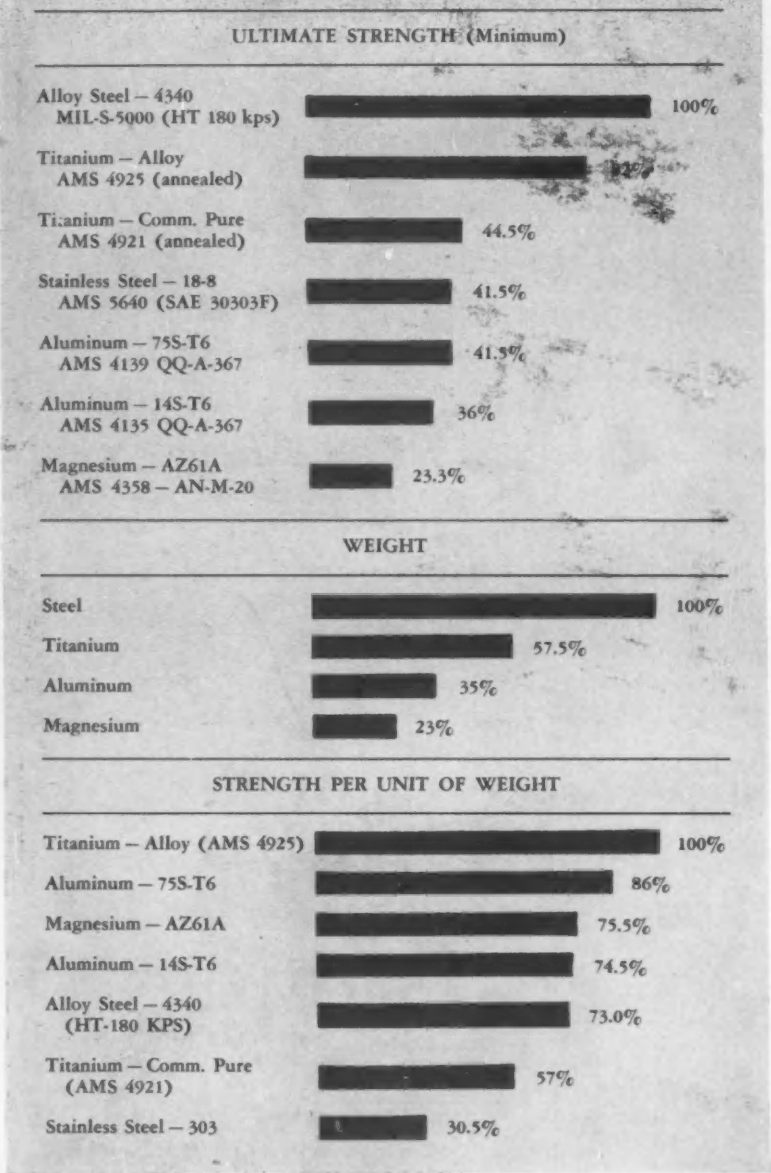
Forging offers important advantages as a means of shaping titanium parts for industrial applications. The problems encountered in fabricating this metal have contributed to the development of special alloys and perfection of technique.

It is particularly important for the designer to have a close working arrangement with the producer of titanium ingot and the forge operator to select the most suitable material and process for the end use. While titanium will not supersede better-known metals, it reacts so well to forging that titanium forged parts are becoming important considerations in design engineering.

Table I – Relative Strength and Weight of Structural Forging Alloys



THREE IMPORTANT ADVANTAGES which titanium offers for industrial applications are:

1. Its high strength-weight ratio
2. Its stability at elevated temperatures
3. Its resistance to corrosion

One of the earliest problems encountered by the titanium industry was the production of ingots with consistently uniform properties. While this problem has not yet been completely solved, considerable progress has been made and fabricators find titanium ingot to be more uniform in make-up and properties. It is now possible to consider titanium for structural applications, particularly where the strength-weight ratio favors the use of the metal. A detailed study of the published data on impact, creep, fatigue and moduli pertaining to the particular pure or alloy metal should be made before selecting them for dynamically stressed applications.

The strength-weight ratio of a material is an important consideration in design, especially where weight savings are indicated. The chart shown in Table I illustrates the strength-weight ratio of titanium as related to other accepted engineering materials. This consideration is further reflected in a greater demand for titanium die-forged parts, especially since this method of fabrication tends to conserve material and machine hours. Furthermore, important work has been done on the development of special titanium-base alloys for forging applications with the result that, today, precision forging of such items as jet engine compressor vanes and stationary rings can be set up as standard operations.

Drop Hammer Forging

Titanium can be forged easily by drop hammer. In the present state of the art it does not, however, fill die contours as readily as alloy steel, stainless steel, or aluminum and, therefore, the impression dies for forging titanium must have large radii and fillets. For intricate drop forgings, more die stages are usually needed for titanium than for steel.

Shrinkage allowance in die sinking is 0.094 in. per ft. compared with 0.187 for dies to forge steel. The surfaces of the dies used for titanium forging must be free from tool marks or other irregularities of finish. The surface of the forging stock should also be free of nicks or scratches. These considerations are necessary to produce titanium forgings which are free of cracks and laps. Special cleaning operations are necessary after forging and trimming to remove scale and surface contamination from the part. Close furnace control is necessary to keep the forging stock in the narrow range of temperature between the minimum (about 1,550 F) below which it begins to have a tendency to fracture and a maximum of 1,650 F recommended to prevent a coarse grained structure in the forged part.

Surface Skin

The forging stock must be brought up to temperature and forged rapidly to prevent excessive formation of a hard skin on the surface of the forging. This skin can be limited to a few thousandths of an inch and has not been found detrimental in machining when properly ground tools are used and a heavy starting cut enters the metal at as nearly 90 deg as possible. There is no effect on the parent material under the surface, but some of the airframe manufacturers are reluctant to leave the skin on parts that are to be used in the as-forged condition. There are several opinions as to the effect of this skin on the mechanical properties of forged titanium but, to date, there is no conclusive data to indicate that this condition is seriously detrimental. To produce a completely skin-free forging, the stock would have to be heated and forged in controlled atmospheres or protected by salt. It has been found at Consolidated Industries that the inherent thin skin produced in normal forging processes can be removed by etching. The cost of special equipment or process to eliminate this skin would increase the forging cost considerably, and be justifiable only if the forging is not machined all over.

Table II—Mechanical Properties of Some Titanium Forging Alloys

	Min. Tensile psi	Min. Yield psi	Min. Elong. %
AMS 4900	65,000	55,000	18
AMS 4921	80,000	70,000	15
AMS 4925	140,000	130,000	10

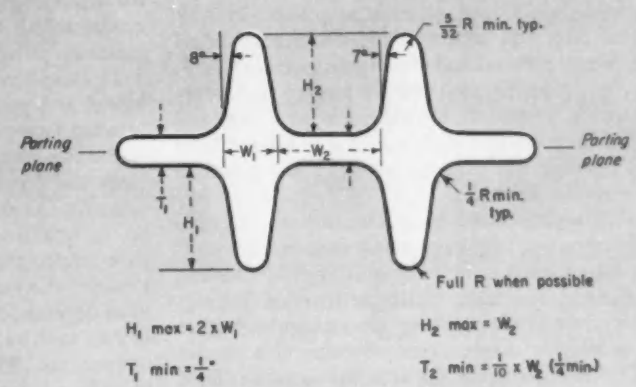


Fig. 1—Recommended dimensional proportions and sectional thicknesses of titanium forgings.

Table III

Length and Width		Die Closure			Mismatch		
Dimensions Inches	Plus and Minus	Net Wt. lbs.	Tolerance Inches Plus	Minus	Net Wt. lbs	Normal Die	Offset Die
Up to 6	0.032	0–¼	0.032	0.010	0–1	.015	0.020
8	0.040	¼–2	0.032	0.015	1–8	0.018	0.025
10	0.050	3–14	0.040	0.020	9–24	0.025	0.032
18	0.062	15–29	0.062	0.032	25–44	0.032	0.040
24	0.078	30–44	0.078	0.032	45–64	0.040	0.048
30	0.093	45–79	0.093	0.040	65–89	0.048	0.062
36	0.109	80–124	0.125	0.050	90–119	0.062	0.087
		125–200	0.187	0.062	120–150	0.093	0.109

Basic Considerations for Forging

Forging stock is available in ingots up to 500 lb. each. The size of titanium forgings is limited more by forging equipment than by the material available. Titanium alloys require approximately the same forging capacity as 75S aluminum, hence these alloys can be forged in the same size range as hand or die forgings. In the actual forging operation, the following criteria is important:

1. Neutral to slightly oxidizing furnace atmospheres should be used.
2. Billets must be free from surface and internal defects.
3. Trimming of flash from the forging should be done while it is still warm (approximately 900 F) and it should be stress-relieved as soon as possible.
4. Most large forgings should be stabilized by holding them between 1,100 F and 1,300 F for periods up to 24 hours.

Basic Considerations for Selection of Material

It is important for the designer to have a close working arrangement with the producer of the titanium ingot and the forge operator to select the most suitable material and process for the end use purpose. Forging temperatures and procedures are then established to obtain maximum results. Test data accumulated to date indicates that forged titanium has an almost negligible difference in directional properties. It has been found, however, that the degree of hot working in thin portions of die forgings

improves the tensile strength beyond the minimum, but without materially affecting the elongation. Both the AMS 4921 and 4925 materials should be forged at temperatures below 1,650 F, to insure good grain structure and prevent excessive surface contamination. New alloys, now being developed, are designed to permit higher forging temperatures.

Dye Design

Titanium alloy is somewhat sluggish in flow characteristics. It is generally comparable to 75S aluminum and requires approximately the same design limitations. Die forging designs should be as generous as possible in draft fillets, corner radii and sectional thicknesses and should not exceed the proportions and dimensions given in Fig. 1. Experience in producing titanium die forgings has established a basis of comparison for tolerances with steel and aluminum. The tolerances shown in Table III are valid for normal die forgings. Unusual configuration of design may justify special tolerances.

The use of forgings rather than bar stock in structural design is common for large production runs, but die costs discourage the production of small quantities of titanium forgings. Limited quantities of simple titanium forgings have been produced in existing production dies that were cut for alloy or stainless steel. Because of a smaller amount of contraction in cooling after the metal has filled the die, a titanium part is slightly larger dimensionally than the steel part. The difference is so slight on small parts (up to 2 lb.) that they are usually within tolerances and regular trimming dies can still be used.

Inspection and Testing

The correlation of strength and hardness has not been found too dependable in titanium forgings, although one producer of ingot has published a curve which could serve for core material testing. The hard skin formed on the surface of forgings as a result of exposure to air during the heating and forging operations is not scale but a case hardness and care must be taken to grind below the slin when taking hardness readings. Until further research reveals a more direct method to test for strength, inspectors will have to rely on representative samples and test bars as they do with magnesium.

Tensile test specimens should be machined all over because the hard surface skin will influence the test results and may also cause slippage in the grips if standard jaws are used. Titanium is non-magnetic, therefore, magnetic particle inspection methods cannot be used to detect cracks or laps. Fluorescent penetrant (Zyglo) or die penetrant (Dy-Check) methods will reveal surface cracks or seams as they do on aluminum and magnesium. The X-ray or reflectoscope will be necessary to explore the inside of the forging for defects.

Use of Titanium Forgings

The use of forgings in structural design will necessitate other factors of consideration beyond the part itself. Methods of attachment, electrochemical insulation, precaution in fits with mating parts as well as machinability must be taken into account according to the characteristics of the metal. Unfortunately titanium has a high coefficient of friction and will gall badly when in sliding contact with other metals. Use with other harder surface materials such as steel or chrome plating is slightly more satisfactory. However, threaded holes in titanium should be avoided.

There are several courses open including surface hardening or otherwise coating external screw threads, but such treatments for threaded holes have not yet become practical. Bolts or rivets through titanium fittings provide a satisfactory method of attachment, but precautions must be taken to prevent electrochemical corrosion. Titanium itself is resistant to almost all forms of corrosive attack, and since it is on the noble end of the electromotive series, the attack of electrolysis will induce corrosion of such dissimilar metals as aluminum, magnesium, steel, and even cadmium plate.

Treatment of faying surfaces is much the same as for Monel and passive stainless steels. Two coats of primer between faying surfaces and a generous fillet at the edges of the two metals should provide adequate electrical insulation and prevent "bridging" of moisture. Rivets used for assembly should be preferably Monel or stainless steel. So far problems in the manufacture of titanium rivets have limited their use, however, several aircraft companies report that whereby cold driving is usually successful it is more dependable for a manufacturing and inspection points of view to drive rivets hot.

Press fits with titanium should be avoided because of its galling characteristics. Even so-called free fits at room temperature assembly often become interference fits at temperature extremes, causing surface and maintenance problems. This is due to an appreciably lower coefficient of thermal expansion of titanium than of most structural metals that may be used for mating parts. Grinding of titanium is now found by most shops to be commonplace. Deep drilled holes more than twice the diameter should be avoided in design because the high friction jeopardizes chip disposal from the hole, causing the drill to load up and subsequently seize with the parent metal.

Surface Treatment

Some internal structures require painting with zinc chromate primer for general protection or appearance. Unlike aluminum, magnesium or steel that must be given a surface pre-treatment before paint, titanium self-oxidizes and holds paint readily. Titanium can be anodized, but unless customer specifications call for this treatment, it is only necessary to degrease the surface before painting.

Conclusion

Current trends indicate that titanium will not supersede the use of steel, aluminum or magnesium, but will find its own place in the designer's catalog of structural metals. Since metal reacts so well to forging practices, it is expected that titanium forgings will be as much a part of engineering design as those other popular metals of today.

EDITOR'S NOTE: Titanium alloy systems are improving constantly. By controlling non-metallics, such as C, O, N, and H, in the sponge and melting phase of ingot production and by the addition of specific metallic elements it is possible to obtain improved properties in forged titanium parts. See "The 3Mn Complex—A New Titanium Alloy" (PE, July 1954, page 172).

Linkage Design Techniques

Comparison of 4 methods —two approximate and two exact— for construction and design of four bar linkages that generate a path passing through given points.

J. C. WOLFORD AND J. C. NICKLAS

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FOUR-BAR LINKAGE DESIGN may require that a point on the coupler link pass through a given series of positions. These positions may be on some specified curve, for instance, they may all be on a straight line, or they may have no particular relation to one another except for the sequence in which the coupler point passes through them. However, the path of the coupler point—hence the design of the linkage—must approximate the specified curve.

Four techniques—to fulfill this type of requirement—are generally considered for designing a linkage:

1. Coupler-curve method. This is an approximate method which involves the comparison of a constructed curve to the corresponding curves of known linkages such as might be found in a catalog or atlas of curves.

2. *b*-curve method. Similar to the coupler-curve method except a plot of the linkage angles must be made. As yet, there is no catalog of *b*-curves similar to those for coupler-curves. However a series is easy to construct.

3. Center-point curve method. This is a theoretically exact technique and involves a certain amount of construction. It is not as easily extended to a large number of given point positions as the first two methods, but it does not require that a catalog of curves be available.

4. Point-position reduction method. Also a theoretically exact technique involving construction. Technique permits a wider latitude as to the number of given points than the center-point curve method.

1. LINKAGE DESIGN BY COUPLER-CURVE METHOD

This method is often known as indirect synthesis since it is an approximate technique using a curve catalog. (Ref. 1) In the example used to compare all the techniques—a four-bar linkage having a coupler point path that passes through the points E_1, E_2 E_3, E_4 and E_5 of Fig. 1, must be determined. A convenient approach is to plot these five positions on tracing paper and to compare the curve through the points with curves from a catalog.

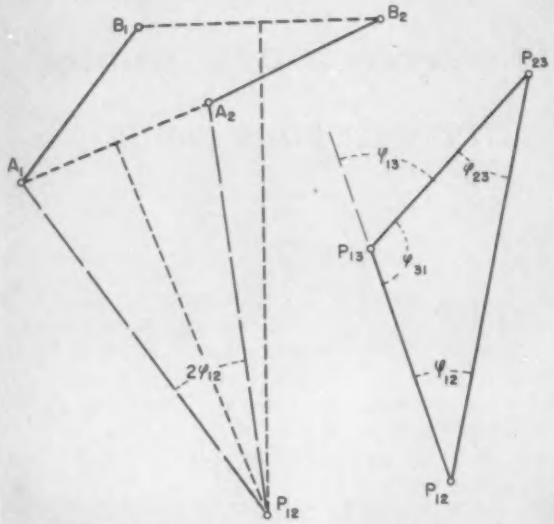
Several satisfactory fits may be found. The mechanism, Fig. 1, was selected from a curve catalog for the given conditions. The five specified coupler point positions do not all lie exactly on the coupler curve, but the error is slight. In any application, there would usually be some tolerance and a perfect fit would not be required.

Poles and Pole Triangles (4)

Poles and pole triangles are used in the construction of the centerpoint curve. Here are some relationships involving poles.

A plane can be carried from one position to any other position by rotating it about a point called a pole. In Fig. A, two positions of a plane are defined by the lines A_1B_1 and A_2B_2. The Pole P_{12} is located at the intersection of the perpendicular bisectors of lines A_1A_2 and B_1B_2. Line A_1B_1 can then be moved to position A_2B_2 by rotating it about pole P_{12}. The angle of rotation is designated $2\phi_{12}$.

If three positions of a plane are given there would be three different poles. P_{12}, P_{23} and P_{28}. The poles P_{13} and P_{28} could be found in the same manner that pole P_{12} was found. These poles describe a pole triangle, Fig. *B*. The vertex angles are $\frac{1}{2}$ of the corresponding angles of rotation from one position to another. These angles are indicated in the figure.



(A) Pole and angle of rotation (B) Pole triangle

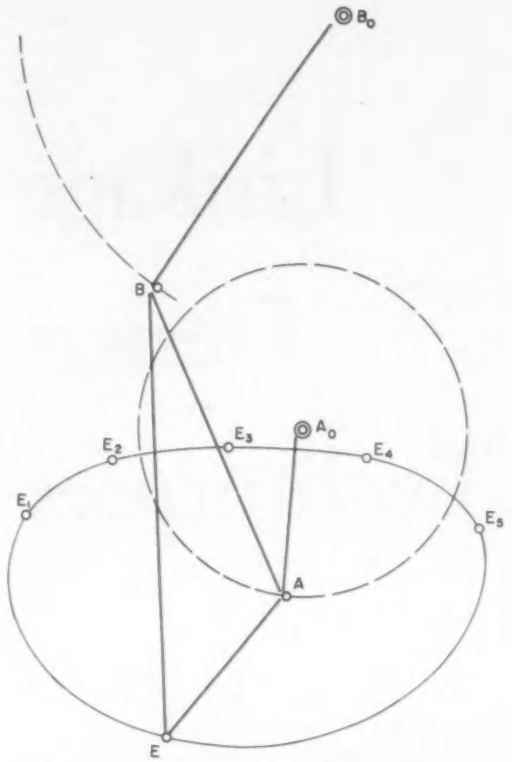


Fig. 1—A four-bar linkage designed by matching the given coupler point position, E_1 through E_5, with a coupler curve from a catalog. Coupler-curve method does not generally allow an exact matching of the given and desired curve.

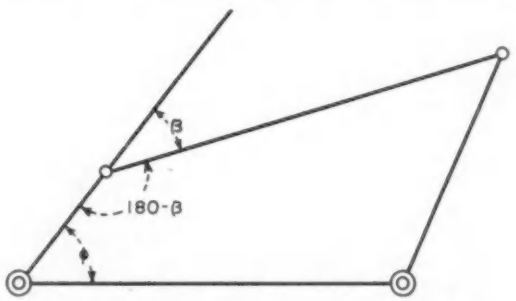


Fig. 2.—In the *b*-curve, the angle β of a linkage is plotted against the angle ϕ. In some instances, a plot of $180-\beta$ vs ϕ is referred to as the *b*-curve. Method requires a catalog of curves for comparison.

2. *b*-CURVE METHOD FOR LINKAGE DESIGN

As mentioned, the term *b*-curve refers to a plot of the angle β of a four-bar linkage vs the angle φ (Ref. 2). See Fig. 2 for definitions of symbols. This technique is also classified as indirect synthesis since it is approximate and a collection of curves of known linkages must be used.

The coupler point is to pass through the five given point positions, E_1 through E_5, of Fig. 3. The location of crank pivot A_0 is chosen arbitrarily and the crank circle K_0 is drawn with the assumed radius A_0A. This radius must be sufficiently large so that a line AE, the length of which is assumed, can have its one end E, on each of the five given points and its other end A, on the crank circle. Thus, using each of the five positions of E as a center and the assumed length AE as a radius, arcs can be drawn cutting the crank circuit at A_1, A_2, A_3, A_4, and A_5. These are the positions of the end of the crank A_0A cor-

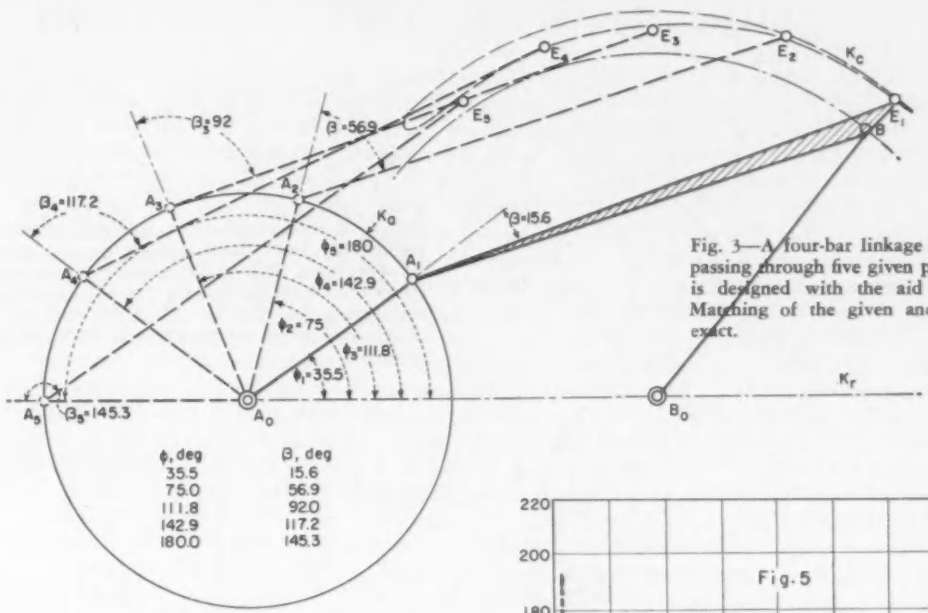
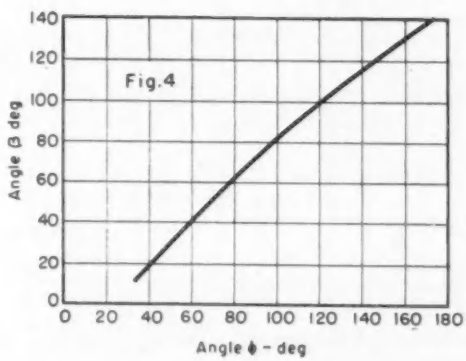


Fig. 3—A four-bar linkage having a coupler point passing through five given point positions. Linkage is designed with the aid of a *b*-curve catalog. Matching of the given and desired curve is not exact.

Fig. 4—Plot of angle β vs angle ϕ. Values are taken from mechanism shown in Fig. 3. This is the *b*-curve of the desired four-bar linkage. Rotation of ϕ is measured from the line K_r. β is the angle between the crank arm and the coupler arm. This curve is shown dotted in Fig. 5. As noted the match is not perfect making the method only approximate.



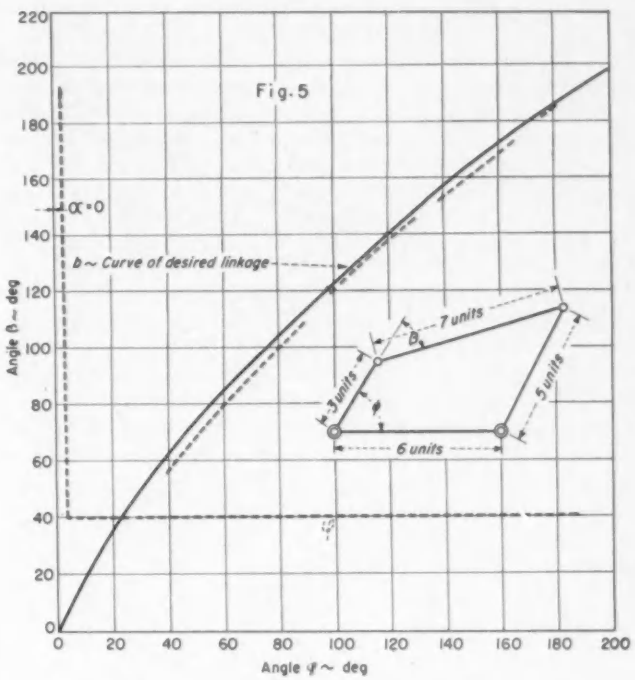


Fig. 5—Curve of four-bar linkage, shown by sketch, to which desired linkage most closely matches. Angle α locates the arbitrarily chosen reference line K_r. Final linkage is designed proportional to the sketched linkage values.

responding to the five coupler positions and $A_1\ E_1$, $A_2\ E_2$, etc. represents one side of coupler triangle in its five positions.

Crank angle φ is measured from some reference line K_r, drawn through A_o, in an arbitrary direction. Angle β is measured from the side of the coupler triangle AE to the crank A_oA extended. Angle measurements are made for each of the five positions and β vs φ plotted as the *b*-curve of the desired linkage, as shown in Fig. 4. The plotted *b*-curve is now compared with known *b*-curves until an approximate fit is found. The curve of the known linkage to which the desired *b*-curve can be approximately fitted is shown in Fig. 5.

In obtaining a fit, the β and φ axes of the desired curve must be kept parallel to the axes of the known linkage curve. The two curves are made to fit exactly at the point corresponding to the design position. For this example, the No. 1 position is the selected design point.

In general, when a fit is found, the β axis of the desired b-curve will be either to the right or left of the β axis of the known linkage curve. If it falls to the right or positive side, the angle φ of the linkage being designed must

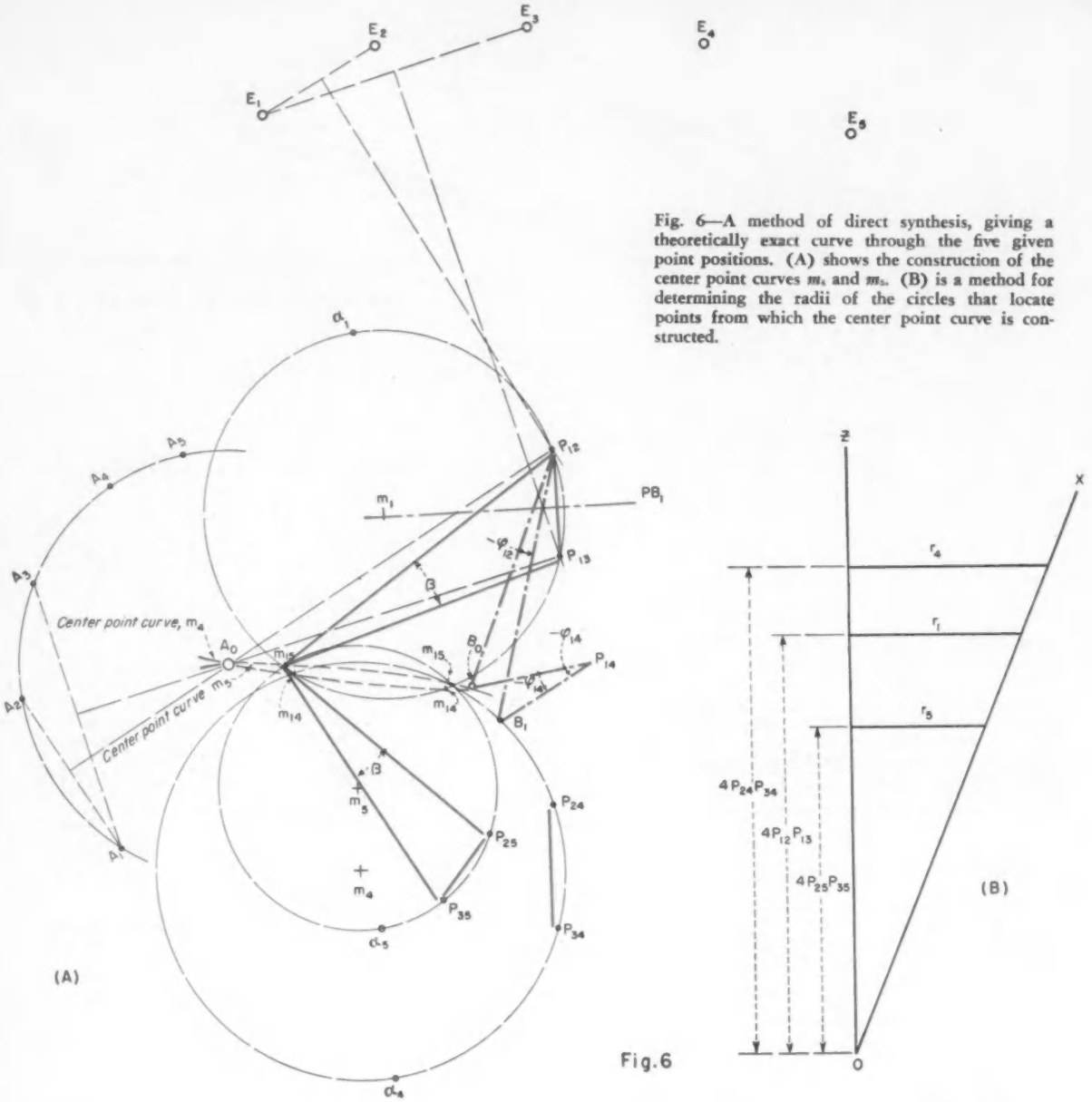


Fig. 6—A method of direct synthesis, giving a theoretically exact curve through the five given point positions. (A) shows the construction of the center point curves m_4 and m_5. (B) is a method for determining the radii of the circles that locate points from which the center point curve is constructed.

Fig.6

be increased by the corresponding number of degrees between the β axes. In Fig. 5, this is designated as α. If the curve falls to the left or negative side, the angle φ is reduced by a corresponding amount. The change is accomplished by rotating the reference line K_r (clockwise for positive valves; counterclockwise for negative valves) about A_0 through the angle α. For this example, α is zero, so the reference line remains in the assumed position.

The fixed link lies along the corrected reference line, K_r. The proportions of the link lengths which generated the known *b*-curve are known. The crank length and the length and direction of the side *AE* of the coupler triangle for the linkage being designed are known. Hence, the complete four-bar linkage with coupler triangle, *ABE*, can be drawn.

If a perfect fit of the *b*-curve is obtained, the point *E* will pass through the five given positions. If the curves do not match exactly at some points, there will be a corresponding lack of coincidence between the given and coupler points. In this example, a perfect fit was not found in the time allotted to the problem; hence, there is a minor variation between the given points and the final curve.

A catalog or atlas of *b*-curves, such as is used for the coupler curves, is not known to be available. However, a mechanism has been designed and built at Purdue University that will mechanically draw b-curves of different four-bar linkages and is used to find a curve fit with the desired motion. Some of the curves drawn by this device were used in finding the fit for the example used in this section.

3. CENTER-POINT CURVE METHOD

This is a method of direct mechanism synthesis involving the use of the center-point curve (Ref. 2). This curve is defined as the geometric locus of the centers of circles that can be drawn through four point positions of a plane when the four positions of the plane are given. If five positions of the plane are given, two center-point curves can be drawn. For instance, one would correspond to positions 1, 2, 3 and 4, and the other curve to positions 1, 2, 3 and 5. The intersections of these curves would locate the centers of circles that could be drawn through the five point positions of the given plane.

If the given plane is the coupler plane of a four-bar linkage, two of the intersections could be used as the fixed pivots. The radii of the circles passing through the five point positions would then be the lengths of the corresponding cranks. In this manner, it is possible to design a four-bar linkage having a coupler point passing through five given positions.

Assume that the five positions of a point on the coupler are E_1, E_2, E_3, E_4 and E_5, Fig. 6(A). Since these five points do not define the five positions of the coupler plane, it is necessary to assume a crank length, A_0A, and fixed pivot, A_0. Thus, link AE of arbitrary length can be used to determine the five points A_1, A_2, A_3, A_4 and A_5 on the crank arm arc, and the five positions of the coupler plane $A_1 E_1$ through $A_5 E_5$.

The center point curve for position, 1, 2, 3 and 5 can be determined by drawing perpendicular bisectors from lines $A_1 A_2$, $A_1 A_3$, $A_2 A_5$, $A_3 A_5$, and from $E_1 E_2$, $E_1 E_3$, $E_2 E_5$ and $E_3 E_5$. The intersection of $A_1 A_3$ with $E_1 E_2$, locates pole P_{12} (see pole and pole triangle explanation). Poles P_{13}, P_{25} and P_{35} are similarly located. The pole polygon $P_{12} P_{13} P_{35} P_{25}$ can be drawn. The polygon is constructed so that no number appears more than once in the subscripts of the opposite poles. Hence, opposite poles, for this example, are $P_{12} P_{35}$ and $P_{13} P_{25}$.

The point m_{15} is constructed, as shown in Fig. 6(B). A line is drawn to a base line at any agle. From point O, the chord length $P_{12} P_{13}$ and $P_{25} P_{35}$ are laid off an equal number of times so that the distance Or_1 is proportional to $P_{12} P_{13}$ and Or_5 is proportional to $P_{25} P_{35}$. r_1 and r_5 are the radii of circles m_1 and m_5 whose center is on the perpendicular bisector of $P_{12} P_{13}$ and $P_{25} P_{35}$. The intersection of the circles is point m_{15}. If lines are drawn from the opposite sides $P_{12} P_{13}$ and $P_{25} P_{35}$ of the pole polygon, to point m_{15} and if the included angle β between lines $m_{15} P_{12}$ and $m_{15} P_{13}$ and $m_{15} P_{25}$ and $m_{15} P_{35}$ are the same or supplementary, the point m_{15} lies on the center-point curve m_5 for positions 1, 2, 3 and 5. Additional points for this curve can be determined by varying the angle of the line OX in Fig. 6(B), with the base line OZ.

In a similar manner, the center-point curve m_4 can be plotted for positions 1, 2, 3 and 4. The intersections of the curves m_4 and m_5 are then points at which the center of a circle through five point positions lies. Since A_0 is the center of a circle drawn through five point positions, A_1, A_2, A_3, A_4 and A_5, it must necessarily lie at the intersection of m_4 and m_5. The other point at which m_4 and m_5 intersect can be used as the fixed pivot for the second crank, B_0 of a four-bar linkage.

The length of crank $B_0 B$ is determined by constructing lines $B_0 P_{12}$ and $B_0 P_{14}$. Lines are drawn from P_{12} and P_{14} at angles from $B_0 P_{12}$ and $B_0 P_{14}$ equal to $\frac{1}{2}$ the angle of rotation from $A_1 P_{12} A_2$ and $A_1 P_{14} A_4$ respectively. These are angle φ_{12} and φ_{14}. φ_{12} is also equal to angle $P_{24} P_{12} P_{14}$ and φ_{14} is equal to the supplementary angle of $P_{12} P_{14} P_{24}$

CONSTRUCTION TO FIND THE CENTER POINT CURVES FOR A FOUR-BAR LINKAGE (See Fig. 6)

ASSUME:

1. E_1 through E_5 are the five positions of a point on the coupler.
2. Crank length A_0 A and fixed pivot A_0

CONSTRUCT:

1. Positions A_1 through A_5 on crank arm arc using arbitrary length AE.
2. Perpendicular bisectors from A_1 A_2, A_1 A_3, A_2 A_5, A_3 A_5 and E_1 E_2, E_1 E_3, E_2 E_5, E_3 E_5 to find poles P_{12} P_{13}, P_{25}, P_{35}. (For simplicity poles P_{12} and P_{13} only are constructed)
3. Lines between P_{12} P_{13} and P_{25} P_{35}.
4. Line OX to any base line OZ at any angle (Fig. 6(B).
5. Lay off lengths equal to P_{12} P_{13} and P_{25} P_{35} along OZ any number of times.
6. r_1 and r_5 are radii of circles a_1 and a_5 whose centers are on the perpendicular bisectors of the chords, PB_1.
7. Intersection of circles is point m_{15}.
8. Repeat above to find center point curve m_{14}. Intersection of a_5 and a_4 is point B_0.
9. Lines B_0 P_{12} and B_0 P_{13}.
10. Angles from above equal to $\frac{1}{2}$ angle of rotation A_1 P_{12} A_2 and A_1 P_{14} A_4.
11. Intersection of these lines locates point B_1.

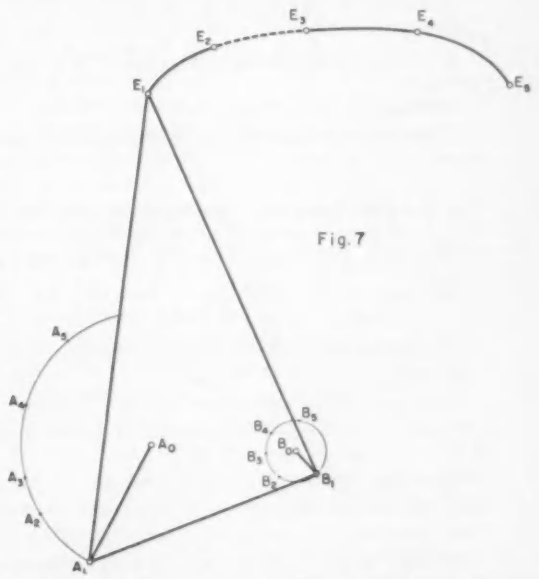
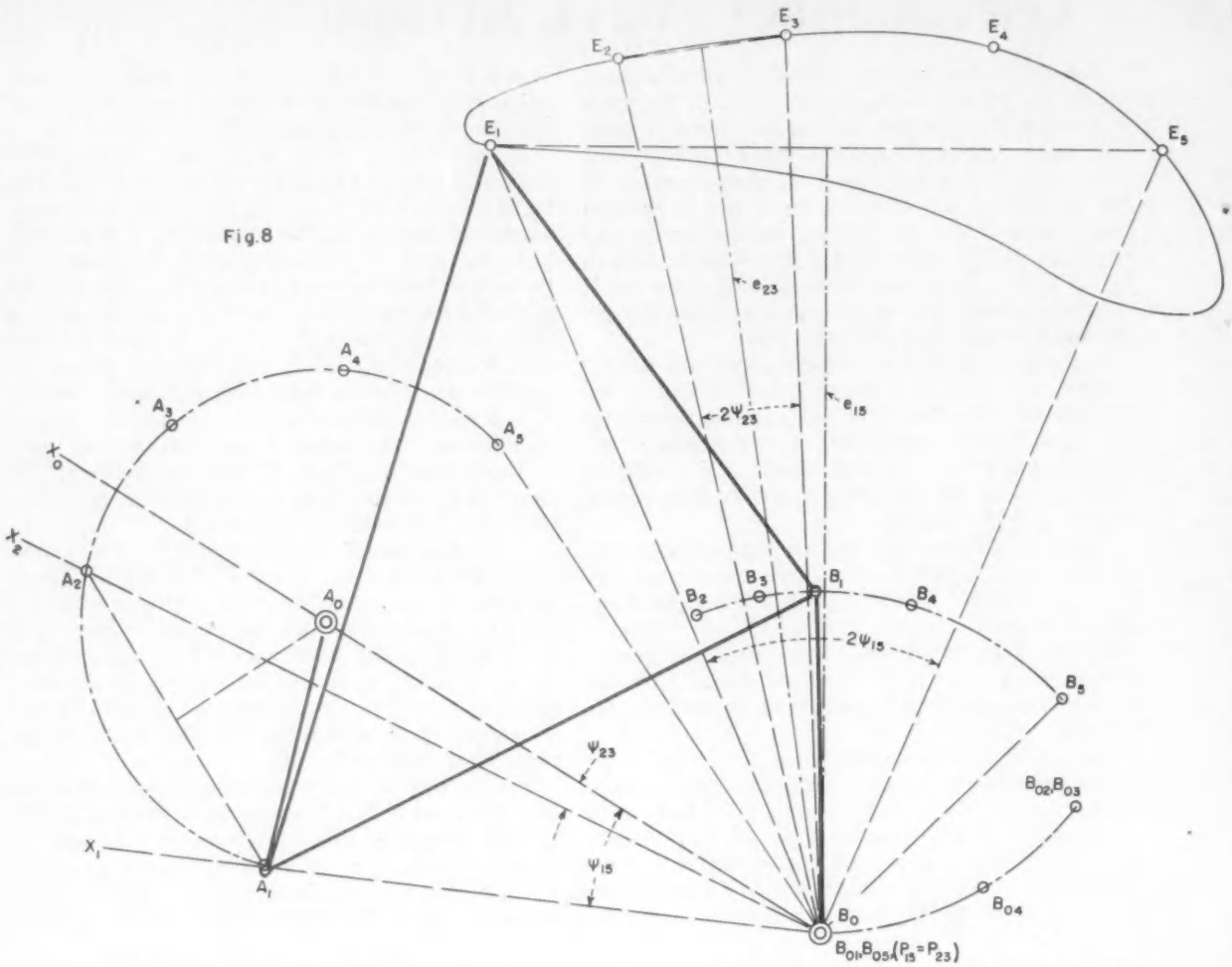


Fig. 7

Fig. 7—Final linkage designed by the center-point curve method for the five given point positions. A discontinuity exists between points E_2 and E_5. For mechanism to work a new fixed pivot point B_0 would have to be found. Center point curves usually permit a choice as to the B_0 position.



CONSTRUCTION TO FIND LINKAGE BY POINT REDUCTION METHOD

ASSUME:

1. E_1 through E_5 are the five positions of a point on the coupler.

CONSTRUCT:

1. Perpendicular bisector from E_1 E_5 and E_2 E_3. Intersection gives B_0.

2. Radial lines from B_0 so that X_1 B_0 $X_0 = \phi_{15}$ and $X_2 B_0 X_0 = \phi_{23}$.

3. Arbitrary length line E_1 $A_1 = E_2$ A_2 and draw circle arcs from E_1, E_2. These intersect B_0 X_1 and B_0 X_2 locating A_1 and A_2.

4. Perpendicular bisector of A_1 A_2 which cuts B_0 X_0 locates A_0.

5. Circle arc with A_0 as center and radius A_0 A. Use AE as radius about points E_3, E_4, E_5 to locate A_3, A_4, A_5.

Fig. 8—Construction of a four-bar linkage, by direct synthesis, that permits a theoretically exact curve through the five given point positions. Method will allow the design of a four-bar linkage with a coupler point passing as many as eight given points. With a greater number of links, more positions can be satisfied. Note that problem is reduced to three points.

of the pole triangle. The intersection of these lines locates point B_1.

For the final linkage shown in Fig. 7, there is a discontinuity between points E_1 and E_2 on the coupler curve. This is because A_1 B_1 + B_1 B_0 < A_1 A_0 + A_0 B_0 which means that the linkages would have to be taken apart and reassembled to move from position 2 to position 3. Such interference cannot be determined until the final dimensions of the linkages have been determined. Point B_0 would have to be placed at another intersection of the center-point curve, or one or more of the arbitrary assumptions changed and the problem reworked.

In this example, the center-point curves, m_4 and m_5 were determined to such an extent that only two intersections were found. Actually, the center point curves may be such that more intersections can be obtained, and the additional intersections would allow a choice as to the B_0 location.

The center-point curve method is the only method that permits more than one solution without repeating the entire construction. Several locations of B_0 are possible when curves m_4 and m_5 are completely defined. Any discontinuity of the coupler point path allows that B_0 location to be ignored and another selected.

4. POINT POSITION REDUCTION METHOD

Point position reduction is a method of direct synthesis which consists of selecting certain important points of the given motion (which in general would all be separate points) such that two or more of these points fall together in a single point (Ref. 3). The end purpose is to arrive at the location of 3 or 4 points through which a circle can be drawn; these points actually corresponding to a somewhat greater number of system positions. It is possible under certain assumptions to design a four-bar linkage with a coupler point passing through eight given positions. Theoretically, the largest number of positions which can be fulfilled with a four-bar linkage is nine. For a mechanism with a greater number of links, a larger number of points can be satisfied.

Assume that a four-bar linkage is to be designed so that a coupler point passes through the five given positions, E_1 through E_5, of Fig. 8. The fixed pivot, B_0, of crank B_0B, is taken at the intersection of the perpendicular bisectors of lines $E_1 E_5$ and $E_2 E_3$. A family of radial lines, $B_0 X_0$, $B_0 X_1$, $B_0 X_2$, is drawn in an arbitrary direction from B_0, with angle $X_1 B_0 X_0 = \varphi_{15}$ and angle $X_2 B_0 X_0 = \varphi_{25}$. These angles are defined as $\frac{1}{2}$ the angle $E_1 B_0 E_5$ and $E_2 B_0 E_5$, respectively. Then with radius $E_1 A_1 = E_2 A_2$ of arbitrary length, circle arcs are drawn about E_1 and E_2 as centers, making intersections A_1 and A_2 with lines $B_0 X_1$ and $B_0 X_2$. The perpendicular bisector of $A_1 A_2$ cuts $B_0 X_0$ at A_0. $A_0 A_1 = A_0 A_2$ is the crank length A_0A. Points A_3, A_4 and A_5 are determined by getting the intersections of the crank circle with arcs drawn about points E_3, E_4 and E_5 as center points and with $E_1 A_1$ as the radius.

All links have now been determined except the location of the coupler and of the second crank in the design position, point B_1. This can be found by considering the mechanism to be inverted with the coupler fixed in position 1 and plotting the five positions of B_0. This is done by taking $E_2 B_0$ as a radius and E_1 as the center, and $A_2 B_0$ as a radius with A_1 as the center. The intersection of the arcs is position B_{02}. Similarly, taking $E_3 B_0$ as a radius and E_1 as the center, and $A_3 B_0$ as a radius with A_1 as the center and swinging arcs, position B_{03} is located. Positions B_{04} and B_{05} are found in a similar way.

Because of the choice of B_0 as poles P_{15} and P_{25}, the points B_{01} and B_{05} will coincide, as well as points B_{02} and B_{03}. The center of a circle through the three distinct points—the intersection of the perpendicular bisectors of $B_{01} B_{04}$ and $B_{04} B_{02}$—will be B_1. The problem, originally one dealing with five points, is reduced to three points.

The procedure for locating the positions of B_0 can be expressed in another way by making triangle $E_1 A_1 B_{05} \sim$ triangle $E_5 A_5 B_{01}$; triangle $E_1 A_1 B_{02} \sim$ triangle $E_2 A_2 B_{01}$; triangle $E_1 A_1 B_{03} \sim$ triangle $E_3 A_3 B_{01}$; and triangle $E_1 A_1 B_{04} \sim$ triangle $E_4 A_4 B_{01}$.

Also, it should be noted that the family of radial lines, $B_0 X_0$, $B_0 X_1$ and $B_0 X_2$, are arbitrary as well as the length AE. These are, therefore, an infinite number of four-bar linkages having a coupler point passing through the given points. Several systems can be determined and the one most favorable in all respects can be used.

COMPARISON OF METHODS

It is difficult to say if any one method is better than another since each method has certain advantages and disadvantages. However, the techniques can be evaluated on the basis of: (1) reliability; (2) ease of application; and (3) selectivity.

The point position reduction method and the center-point curve method are probably the most reliable. The other two methods rely strongly on the availability of a good collection of coupler or b-curves as provided by a curve catalog. Also, the point position reduction method and the center-point curve method are more direct; however, the other two give more control of the complete path of the coupler point. One requirement of a linkage might be that the driving crank be capable of complete revolution. There is no assurance that the linkage determined by the first attempt with the two direct synthesis methods will be capable of this. For example, the linkage resulting from the first attempt by the center-point curve method was incapable of going from position 2 to 3. Furthermore, even if this had not occurred, the driving crank A_0A could not make a complete revolution. For any given problem several attempts might be necessary to get a satisfactory linkage. By the indirect synthesis methods, if small errors in the coupler paths are not objectionable, a single check of the curves is sufficient.

The method most easily applied is the one involving the use of a catalog of coupler curves. The most difficult method to apply is probably the center-point curve; one reason being the difficulty in obtaining the accuracy needed to get a solution that will check.

Selectivity can be defined as the number of solutions that are available and their accuracy at the five given points. Obviously, the coupler-curve and b-curve will not give exact solutions unless the curves fit exactly at the specified points. The point reduction method and the center-point curve method of an actual solution, however, will depend upon the accuracy of construction. The only method that might make more than one solution available without repeating the entire construction or curve fitting is the center-point curve method. The center-point curve might intersect at more than two points and give some choice of location of the second fixed pivot.

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Keeping Products QUIET

MEASURING MOTOR NOISE in General Electric's new anechoic sound chamber

Basic approach to sonance design—the development of optimum noise characteristics—recognizes that noise originates as a force acting on a vibrator, through a transmission path to a radiator. Using the induction motor as an example—because it includes magnetic, turbulent air and mechanical sources—specific methods of reducing product noise are presented.

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AN EVER-INCREASING NUMBER of people are becoming aware of the hums, clicks, whistles and roars which are commonplace today in working and living areas. With this increasing awareness has come an active—sometimes militant—interest in noise, ranging from mildly annoying low-level noise of a bedroom electric clock to the effect of machinery noise upon the health and efficiency of industrial workers. A common source of such noise is the electric motor; other typical examples are the jet engine, a power transformer or a fan. But the type of noise, its source and methods for reducing the intensity are much the same for all of these sources.

Much effort has gone into determining the design factors which can minimize the noise-producing potential of a product. In general, factors influencing noise are not related to performance. It is quite possible that a device designed to have optimum operating characteristics may be very noisy, and unfortunately, the converse is also true—that machines designed to operate quietly may be inefficient.

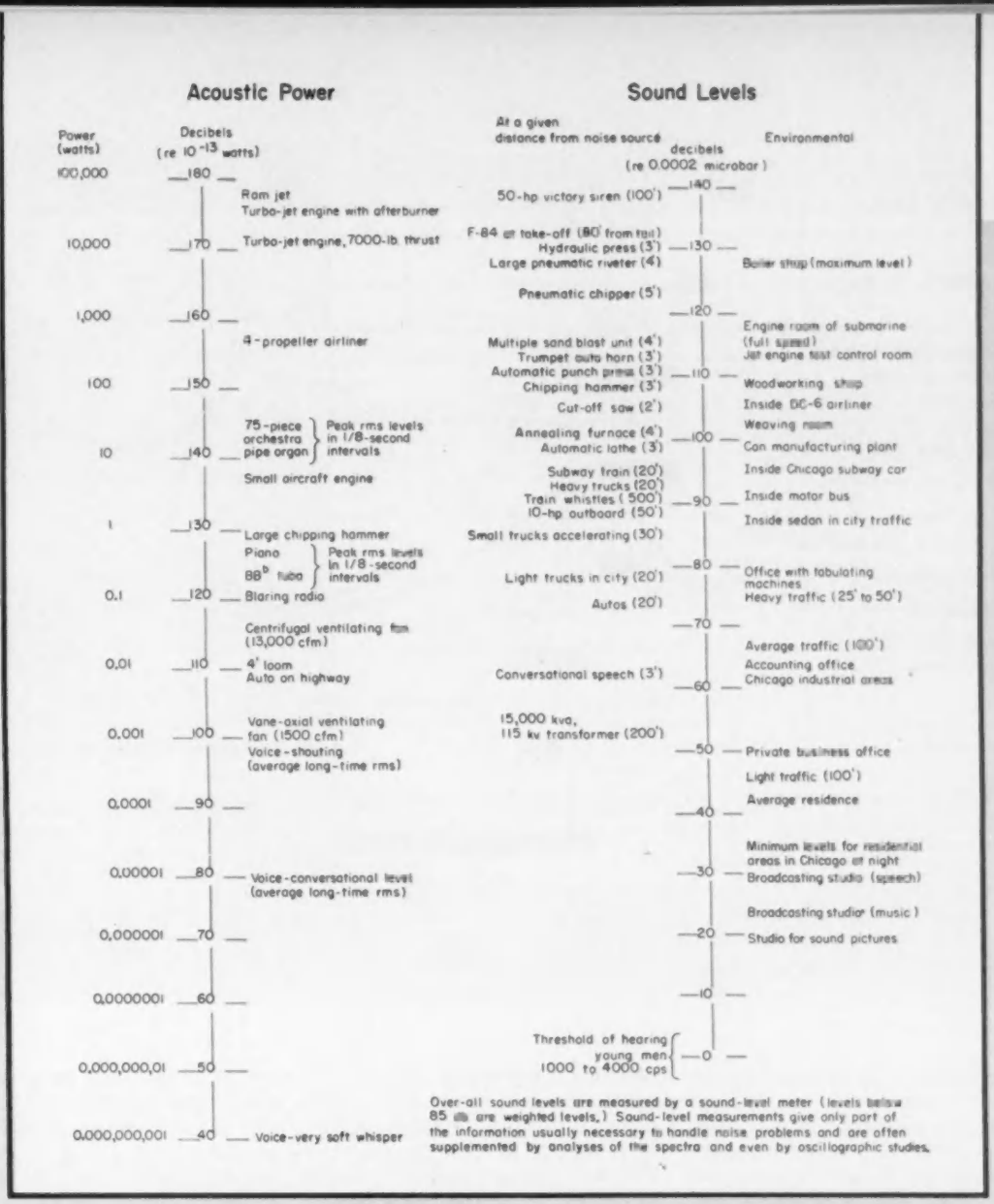


Fig. 1—Left-Acoustic power in watts and in decibels for various sound sources. Decibel ratios are based on 10^{-13} watts as the reference level. Right—Sound intensity as measured by a sound-level meter at distance shown from a variety of industrial and everyday noise sources. These over-all measurements often must be supplemented by analysis of the sound spectra to determine the steps to take in reducing sound intensity. *(From "Handbook of Noise Measurement" by A. G. Peterson and L. L. Beranek, General Radio Co., Cambridge, Mass.)*

Therefore, design for control of noise remains a separate problem. In much the same way that appearance design has been integrated into product engineering, so must "sonance" design—the development of optimum noise characteristics—become part of standard design procedures.

Magnitude of the energy involved in sonance design is small. For example, in a 100-hp electric motor driving a 5-ton factory crane, the losses from bearings, windage and other sources may be about 4500 watts, or 6 per cent. The noise (sound power) produced by such a motor is roughly equivalent to that of a blaring radio, yet the energy converted to noise is no more than 0.1 watt or about a *ten-thousandth of one per cent* of the rating of the motor, an energy level that cannot be detected by any normal means. If the motor noise level were to be lowered considerably, say to the approximate level of someone shouting, it would represent a conversion of about 0.001 watt of energy. Such quantities of energy are fantastically small compared to the output of the motor but they are all that is needed to cause the noise sensed by the ear.

Although the human ear can detect minute amounts of energy, its output

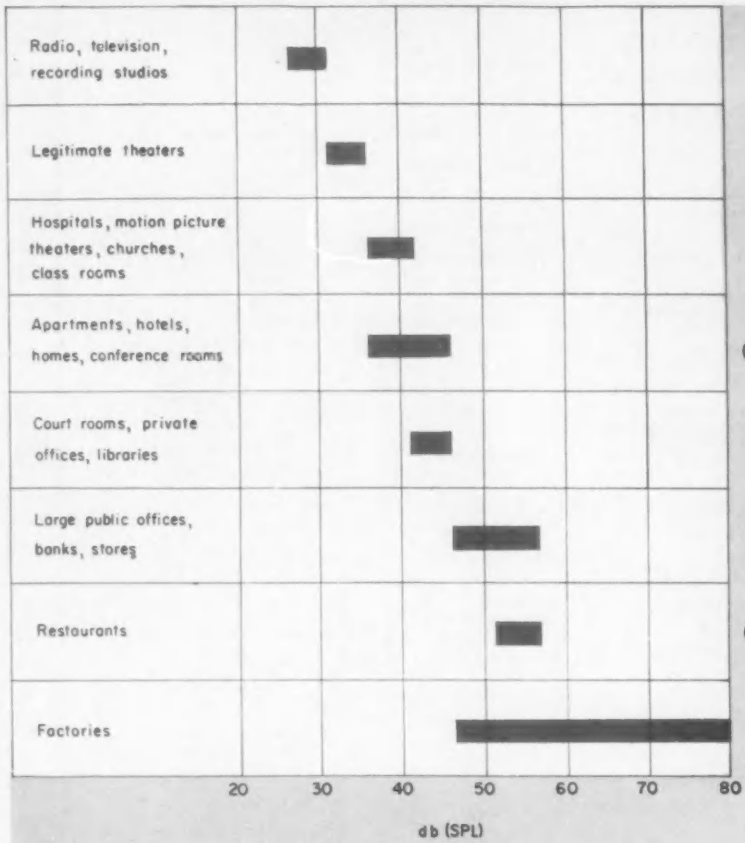


Fig. 2—Acceptable noise levels for common environments.

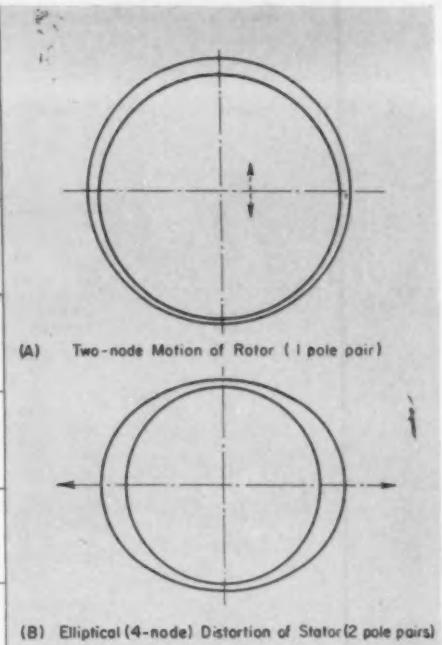


Fig. 3—Elastic deflection of rotor shaft and housing under magnetic forces in 2-pole and 4-pole induction motors produces a noise source at a frequency which is a multiple of the rotating speed. When natural frequency corresponds to vibration frequency sound level is increased.

(psychological sensation) is not strictly proportional to its input (sound pressure on the ear). Further, it does not add the various incident sound components in a true arithmetic manner and it is not equally sensitive to all frequencies. Qualitative comparison of noise levels is of limited usefulness; expressions such as "as much noise as a freight train" mean different things to different people. It is more useful to compare noise levels to a common reference by means of suitable instruments giving quantitative measurements without appealing to memory and experience.

SOUND INTENSITY MEASUREMENTS

Quantitative measurements of sound are based either on the acoustical power level, or on the sound pressure. The sound pressure level is related to acoustical power under specific environmental conditions, and both are expressed in decibels—a ratio of any two power or pressure levels. Acoustical power level is measured in watts, and the number of decibels n_w denoting the ratio of two sound power levels is given by

$$n_w = 10 \log \frac{W}{W_o}$$

where W_o is the reference level, usually taken as 10^{-13} watts, and W is the level being measured. (For more detailed information, see L. L. Beranek, *Acoustics*, Wiley, 1954.) Fig. 1 gives the acoustic power levels of a number of typical sources.

The sound pressure level varies as the square root of the sound power; thus, the decibel value n_p or the ratio of two sound pressures is

$$n_p = 20 \log \frac{p}{p_o}$$

where p is the root-mean-square sound pressure of the sound being measured and p_o is the reference sound pressure level (usually taken as 0.0002 microbar where a microbar is a pressure of one dyne per sq cm). Sound levels of typical sources are also given in Fig. 1.

When another noise source such as an electric motor is introduced into a room where the noise level is known, the effect of the addition cannot be obtained by adding decibel levels. Two noise levels of 80 db each do not combine to produce a level of 160 db. The combined level of several sound sources is determined by first converting the decibel values of each to their equivalent energy values, adding the energy values, and then reconverting this total energy value to a combined decibel level. Thus, two 80-db power levels will combine to produce a resultant level of 83 db.

The range of desirable sound levels in terms of sound pressure for some typical locales is given in Fig. 2. The

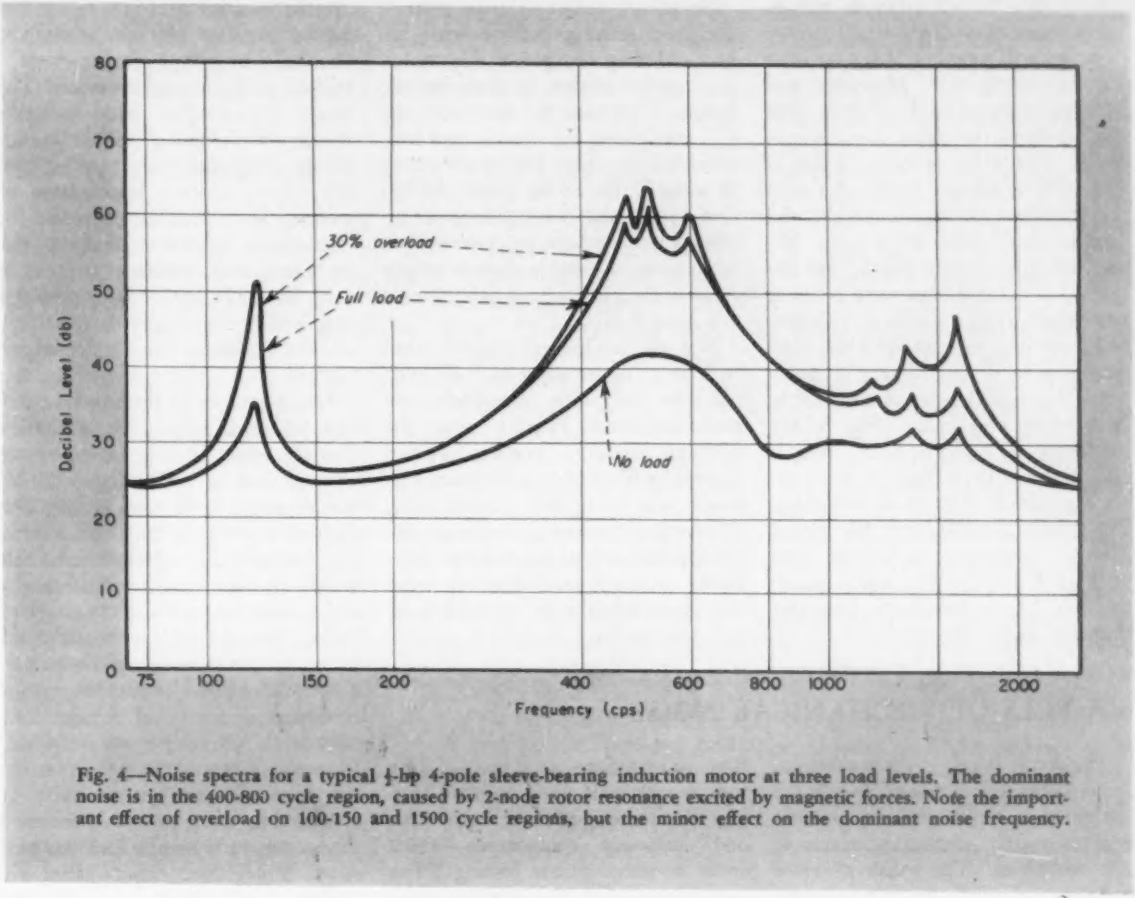


Fig. 4—Noise spectra for a typical ½-hp 4-pole sleeve-bearing induction motor at three load levels. The dominant noise is in the 400-800 cycle region, caused by 2-node rotor resonance excited by magnetic forces. Note the important effect of overload on 100-150 and 1500 cycle regions, but the minor effect on the dominant noise frequency.

values shown are in db measured on the 40-db frequency-weighting network of a sound-level meter. While other methods for presenting this type of information are available, this particular method is indicative of relative levels.

In the origin and transmission of air-borne noise from any mechanical device the noise must originate with a force which causes a part to vibrate. Then, either the vibrating member, or another to which the motion is transmitted, serves as a radiator. From origin to detection, any noise follows the sequence:

Force—Vibrator—Transmission Path—Radiator.

If the transfer of energy between any two points in the sequence can be reduced, there will be a corresponding reduction in the noise produced. It is a function of sonance design to minimize objectionable noise by selecting the optimum point in the sequence to reduce the transfer of energy.

REDUCING MOTOR NOISE

Induction motors are being used more widely today than ever before; many where noise is a sensitive problem such as in television cameras, air conditioning equipment, electric typewriters, machine tools, boiler feed pumps and forced drafted blowers, with motor ratings from fractional-hp to as large as 5000 hp.

Induction motor noise originates from three principal sources: (1) magnetic noise, (2) cooling air, and (3) mechanical noise. In fractional-hp motors, magnetic noise is the most common source of trouble. In large motors (greater than 1000 hp), cooling air noise usually dominates. Bearing noise problems are encountered in medium motors, largely because ball bearings are used. In general, mechanical noise due to unbalance or bearings does not appear as a major source of noise in any one category but it can be the dominant noise source in individual motors of any size.

Magnetic noise is caused by radial magnetic forces which act in the air gap between the stator and rotor. The forces are periodic, almost always non-sinusoidal, and occur in harmonics of the fundamental. The motions of rotor and stator which are caused by magnetic forces of two different pole pairs are shown in Fig. 3. A single pole-pair force tends to move the rotor as a whole in a simple oscillatory motion without any distortion. A two, three, or higher pole-pair force does not have any appreciable effect upon the rotor, but does tend to distort the stator into elliptical or more complex shapes. Only those forces with low-order pole structures are important as potential noise-producers; force waves

with higher than 8 poles do not directly cause noise.

In general, magnetic forces are most harmful when their frequency and pole structure coincide roughly with the resonance of either the rotor or stator. The noise spectrum (a plot of frequency vs decibel level) of a ½-hp motor is shown in Fig. 4 in which the predominant noise is between 480 and 600 cps. In this motor, the frequency of a 2-pole-force wave is nearly coincident with a mode of vibration of the rotor; as a result the noise component near 500 cps in Fig. 4 dominates the overall noise of the motor. In another ½-hp motor, Fig. 5, the frequency of a 4-pole-force wave is almost the same as that of the four-node mode of vibration of the stator. The noise spectrum of this motor shows a dominant component from 1000 to 1600 cps—the region where this coincidence of magnetic force and stator resonance occurs.

By proper sonance design most of the lower order pole-force waves can be avoided by (1) proper selection of the number of slots in the rotor and stator, (2) skewing the rotor slots, and (3) minimizing the number and magnitude of the mechanical imperfections of some of the motor parts. Motors with certain slot combinations are extremely noisy; other combinations tend to be quiet. Desirable skew is usually equal to the pitch of one or preferably two rotor slots.

Not all mechanical imperfections built into a motor affect its noise level, but rotor and stator eccentricity and out-of-roundness interact with the magnetic fields to produce so-called dissymetry forces with a low pole-order which are particularly troublesome. Close tolerances and good quality control can help reduce the effect of these forces, although even relatively small imperfections have an appreciable effect on noise level.

SOURCES OF MECHANICAL NOISE

The forces which cause mechanical noise in induction motors usually are attributed to rotor unbalance and the effect of bearing lubrication, clearances and tolerances. The forces of rotor unbalance of course can be minimized by careful balancing. They may cause resonant vibration of some motor parts or the structure on which the motor is mounted. The vibrations become important only when a radiator is excited by repeated impacts. If the vibrator is a part of the motor it can be redesigned for a higher or lower resonant frequency. To minimize sound transmission from the structure upon which the motor is mounted, a properly designed resilient mounting system can be used.

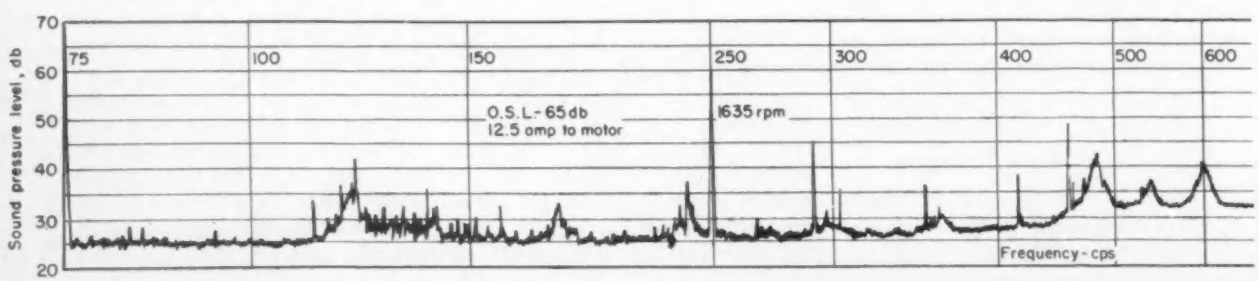
Bearing noise is reduced considerably by using sleeve bearings rather than ball bearings. In a class of ½-hp motors with both sleeve and ball bearings the noise spectra of both types had frequency components which could be traced to the bearings. The bearing noise of the average sleeve bearing motor was about 30 ± 2db, while the ball bearing motors varied from 35 to 50 db with an average close to 45 db. The noise of ball bearings will vary widely and is affected by the size and weight of the bearing, the type and amount of lubricant used, the rotating speed, and the mounting fit. In general, a slowly rotating, small but heavy bearing which is mounted snugly and well-lubricated will be quiet. Such characteristics usually are not feasible; if quiet performance is essential, sleeve bearings are used.

The most severe mechanical noises are the result of resonance rather than forced vibration. In almost any mechanical device some resonance will be excited during normal operation. This leaves the designer with the poor choice of designing around certain critical frequencies or requiring that the noise-producing forces from all sources be eliminated. Usually, the compromise solution is to design major parts with resonant frequencies away from 120 cps or integral multiples, and to use tolerances, clearances and fits as close as can be met in production.

Cooling air noise in induction motors is caused by (1) the turbulent flow of cooling air, (2) the resonance of parts such as fan blades in the air stream and (3) a siren effect. The flow of cooling air over and around many sharp-edged surfaces is turbulent, which produces no single-frequency components but a shushing sound or "white" noise. In large installations which warrant it, this noise can be adequately attenuated by building acoustically-treated inlet and exhaust duct work as an integral part of the motor. In smaller motors such procedures are not practical and it is necessary to eliminate the noise at its source rather than attenuate it after it has been produced.

The air noise level of a motor increases with fan diameter, volume of air moved, and speed. Any change which makes the flow less turbulent will reduce the noise level correspondingly. Such frequency components as the resonance of fan blades can be detected readily in the ventilating noise, but are usually of lower magnitude than noise of turbulence.

In fairly large motors where the cooling air flows radially through slots in the rotor, across the air gap and out corresponding slots in the stator, the air noise at operating speeds will often dominate the noise spectrum



of the motor; the noise level may well be as high as 105 db in a 1000 hp motor. The most common means for reducing siren noise is to set back the rotor and stator conductors away from the air gap, and streamline the rotor exit and stator inlet areas. Reductions of 20 db are possible by these means.

MAGNETIC HUM IN STATIONARY DEVICES

An induction motor has been used as an example because it includes a variety of typical noise sources—magnetic, air turbulence, and mechanical—with a wide range of frequencies and also brings in the problem of resonance. But magnetic hum can be a serious source of noise even with no rotating or moving parts. In power transformers, for example, the noise is principally caused by one source, the motion of the transformer core. (See *Electrical World*, Dec. 1952, page 94). Magnetostriction vibrates core laminations in the direction of magnetization at about 1 to 2 microinches per in. of lamination length. In a large transformer the laminations may be as much as 10 ft long which would correspond to vibration amplitudes greater than 0.00005 in. This vibration of the core causes pressure fluctuations in the oil in which it is immersed and excites the tank of the transformer which serves as a radiator. A parallel path to the tank is provided by the core supports that connect directly to the tank—again the Force-Vibrator-Transmission Path-Radiator sequence. Although the relation between noise level and magnetostriction is not well known a high degree of correlation does exist.

Of the two paths by which the vibration of the core is transmitted to the tank in a typical power transformer (direct mechanical coupling through the core supports and through the insulating oil) both are of about equal effectiveness in noise transmission. Rigid core supports can be replaced by a system of resilient mountings such as pads of oil-resistant rubber loaded in compression, shear mountings or spring suspensions. A tank base is far from a fixed, rigid foundation at 120 cps; thus, it is desirable to make the base as rigid as possible by aligning the core support points and the concrete foundation or by bracing the tank bottom.

The noise transmitted via the insulating oil could be attenuated most effectively by using an air barrier between the core and the tank. In general, such a barrier would be most effective if it is thick, close to the core, and the tank wall is stiff. Barriers of this type will attenuate the noise from the core by more than 10 db.

The next step in the design procedure is to minimize the effectiveness of the tank panels as radiators at 120 cps and its harmonics. This can be done by bracing the panels or otherwise changing their modes of vibration near these frequencies. Where this is still not adequate, noise can be reduced by enclosing the transformer in an acoustically-treated case.

The common denominator in the sonance design of the two examples cited here is the consideration given the sequence

Force–Vibrator–Transmission Path–Radiator

The most effective sonance design will minimize noise-producing forces, reduce the energy transfer between any two items in the sequence or combine both of these methods. In general, only in small devices is it possible to reduce noise-producing forces to negligible magnitudes. In addition, because of an inherent perverseness in the nature of his problems, no engineer can design around all critical frequencies. He can consider only the worst offenders and build his design accordingly. In most cases, some means can be found to insert a barrier which will essentially interrupt the transmission path, or the effectiveness of the radiator can be reduced.

In a continuing evaluation of noise as a design problem, three earlier articles have discussed noise and vibration in ball bearings, reduction of noise in hydraulic systems, acoustical materials for noise control and an analysis of noise reduction in machinery.

"Noise and Vibration in Ball Bearings," Dec. 1951, page 150. Symptoms and causes of bearing noise in products; design factors that influence noise potential, including bearing clearance, dynamic balance, effect of thermal expansion, and electrical noise.

"Hydraulic Noise Reduction," Feb. 1952, page 178; March, page 135; April, page 182. In this series of three articles on noise in hydraulic systems, the first article discusses the importance of pump design; the second explains the use of capacitive loading chambers in reducing noise; the final article on fluid conditioning shows the effect of air in systems.

"Reducing Product Noise With Acoustic Materials," Sept. 1952, page 162. Trial and error technique using absorbers, insulators and vibration dampers; performance data on insulators and damping materials commonly used in automotive applications.

"Noise Reduction in Machinery" Dec. 1953, page 172. Analysis of types of sources and construction of a noise-flow diagram as an aid in reducing airborne noise; general discussion of the importance of impact forces and the use of vibration isolation, acoustical insulation and damping materials.

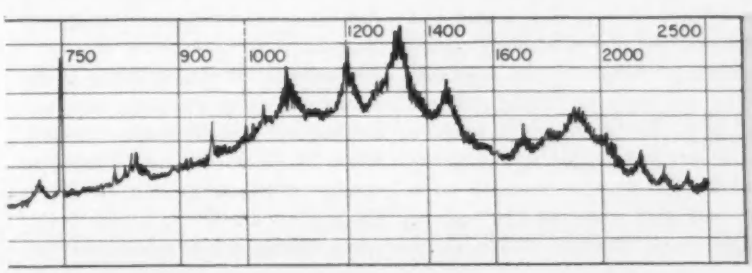


Fig. 5—Noise spectrums for a motor similar to the one in Fig. 4 except that the dominant noise is caused by 4-node stator resonance. Note that maximum noise is in 1000-1600 cycle region.

DESIGN FEATURES

(A)

(A) MOLDED CLEAR ACRYLIC dial with hot stamped graduations on inside surface permits a visual check on elapsed time, motor operation, clutch engagement and wear, and contact actuation at cycle end. Decorative effect is obtained from silver deposited by vacuum metallizing process. Dial is curved to give necessary lens effect for concentration of light and maximum visibility.

(B) EASE OF DISASSEMBLY for adjustment and maintenance is a big feature of the new design. Only two tools are required for servicing, a screw driver and socket screw wrench, the latter being used solely for adjusting the load contact sequence screws and tightening the cap screw in the dial knob. Construction simplicity also points up another feature. It lends itself as an ideal sales tool—it can be taken apart and reassembled in a matter of seconds.

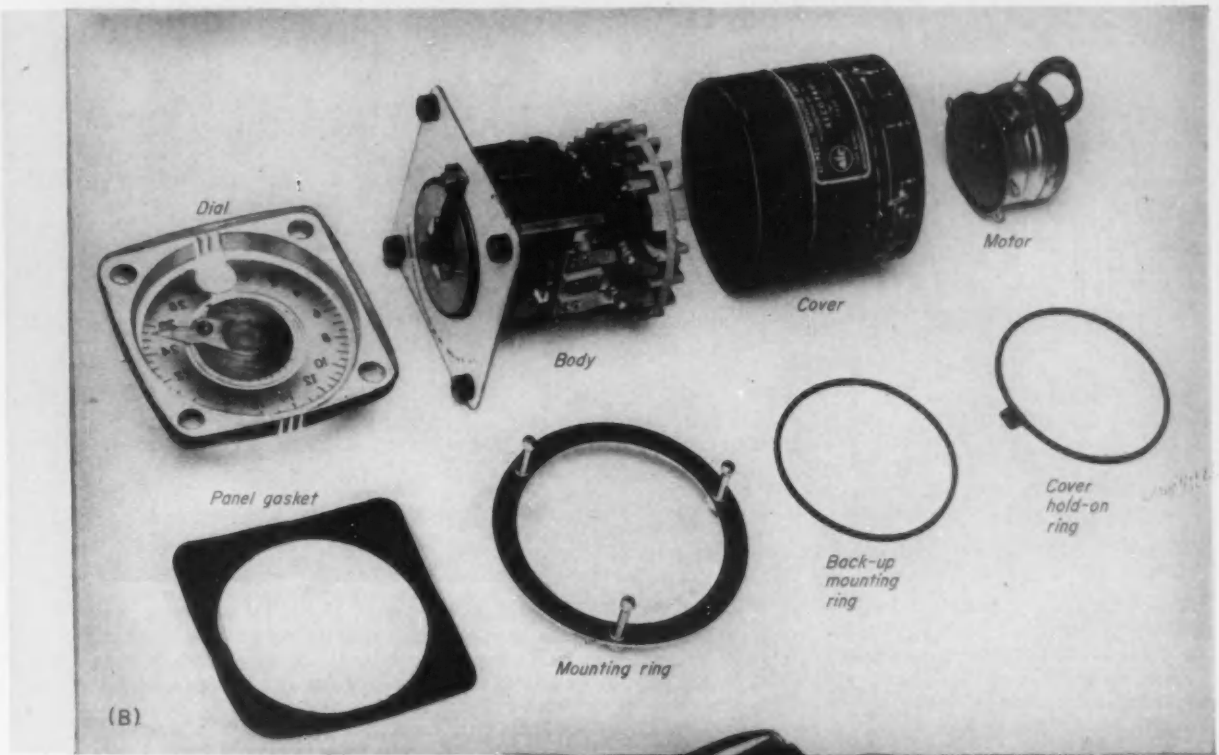
Reset Timer for Automatic

Four design goals underlie the development of Automatic Temperature Control Co.'s new dial type reset timer for machine and process control applications: (1) *Cost* to be competitive with similar timers on the market; (2) ***miniaturization*** to make panel mounting space requirements less than competitive models; (3) *appearance* to portray functional styling to achieve the eye-catching trend in panel design; and (4) ***versatility*** as afforded by maximum operating flexibility. Because of these primary objectives and the over-all requirement that design improvements must not compromise product dependability, a completely new design approach was adopted. What resulted was a timer featuring design simplicity, ease of maintenance and installation, and a high level of repetitive accuracy.

Probably the most interesting design feature of the timer is the novel use of O-rings. One ring is used as a back-up ring for the metal panel-mounting tension ring on the timer cover; another holds the slip-on cover in place plus acting as a positive vapor seal against the terminal block; and a third ring is mounted on a grooved disk plate which, with a single tooth element makes up a simple but highly effective clutch.

One-piece plastic molded-dial features the emphasis on appearance. To preserve its clearly styled lines, a novel expansion type retaining device fastens the dial to the front flange of the timer body. This fastener design eliminates the need for conventional mounting panel holes or protruding nuts.

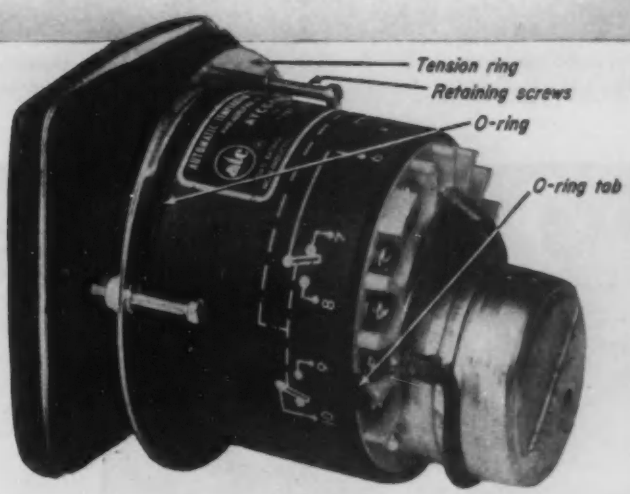
Flexibility of timing cycles is obtained by using the same internal mechanism for all timing ranges, from 15 sec to 240 min. Only the timing motor and dial need be changed to use the timer for a different timing range. Additional ver-



Control

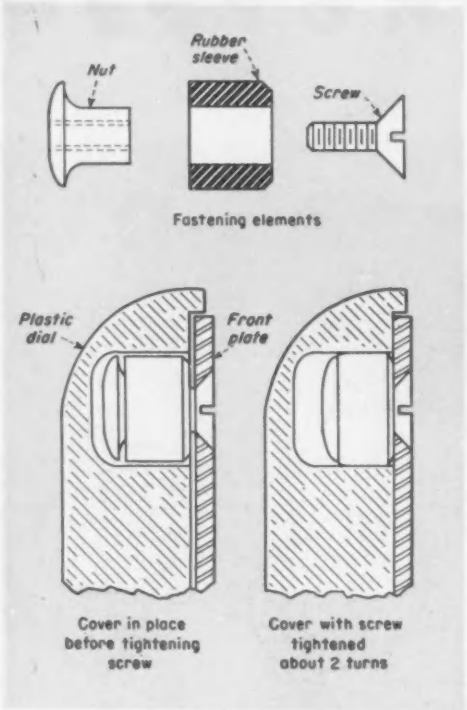
satility is achieved by simply changing the pivot of the clutch actuating rocker arm. This permits the timer clutch to either disengage upon power failure or to remain engaged and then be disengaged when power is restored.

Electrically, the timer has been designed to perform over 145 different circuit operations. This is possible by combinations of reset and non-reset, momentary and sustained starting impulse, two SPDT load switches and a DPDT clutch relay. Typical applications are centrifuges, mixers, deep well pumps, plating tanks, and induction heaters.

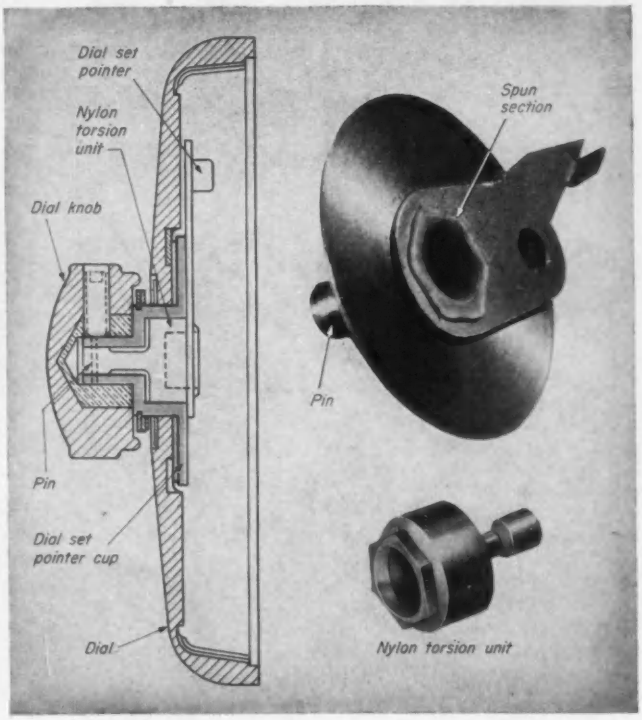


PANEL MOUNTING of the timer consists of merely threading the retaining screws until they securely contact the panel. Back-up pressure is supplied by an O-ring which fits in a circumferential groove around the timer body and holds the metal tension ring in position. Also shown is the O-ring securing the slip-on cover to the timer body. Ring fits into a recess formed by edges of cover and terminal block; plastic tab is for quick removal.

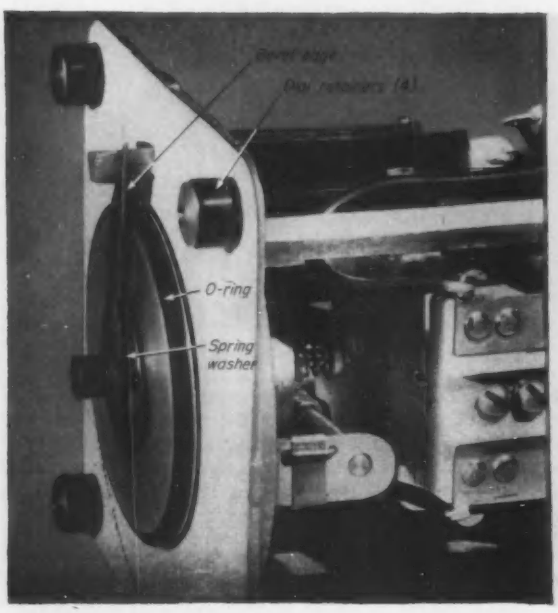
Reset Timer (continued)

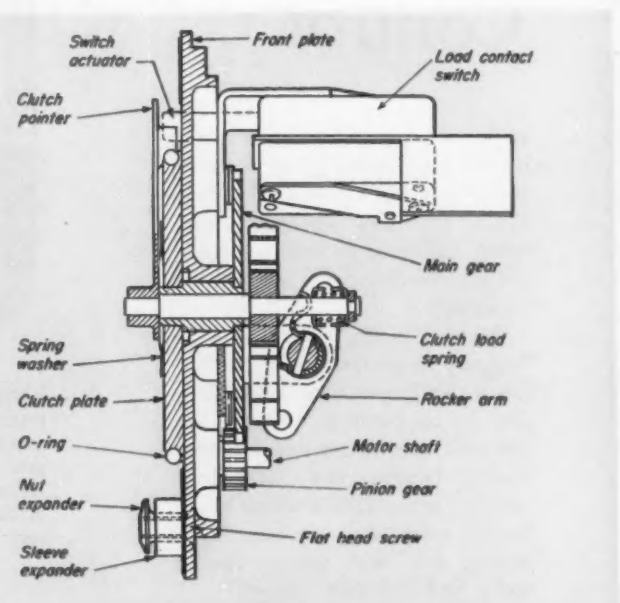


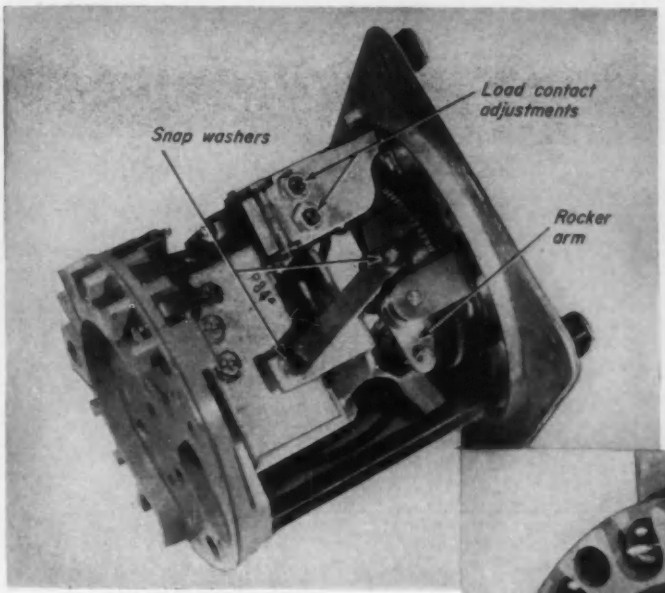
DIAL ASSEMBLY is removed or installed easily by loosening or tightening four screws on the back of the aluminum die-cast front flange assembly. When in place, the dial is secured firmly by an expander nut, expanding rubber sleeve and flat head screw. As the screw is threaded into the nut, it pulls the nut into the sleeve with the bevel on the nut surface expanding the rubber sleeve against the sides of the hole in the dial, which is fabricated of plastic.



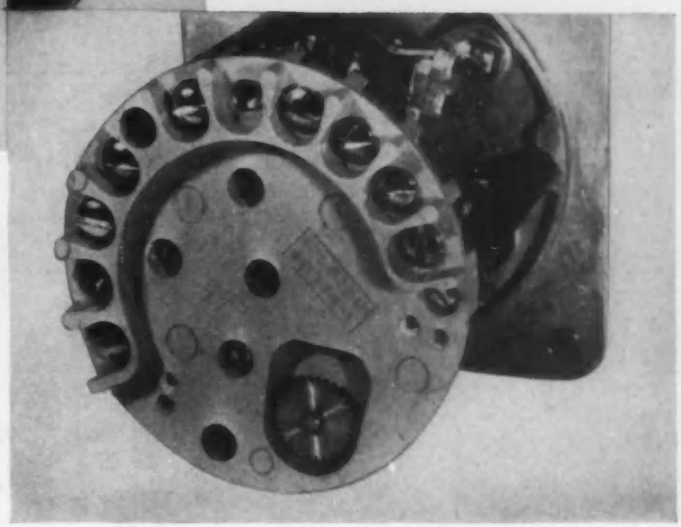
A NYLON TORQUE TUBE fastened to the dial and setting pointer knob eliminates all detectable rebound of the pointer upon its return to "zero" from its "end-of-cycle" position. Nylon element is inserted in the dial set pointer cup, trimmed at one end and spun integral at the other end with the pointer. Thus, when the clutch is released and the indicating pointer returns to "zero", the pointer strikes a projecting lip on the setting pointer. Since the setting pointer is attached to the nylon element, it acts as a shock absorber, thereby eliminating, to a large degree, lapsed time for settling-down at reset.



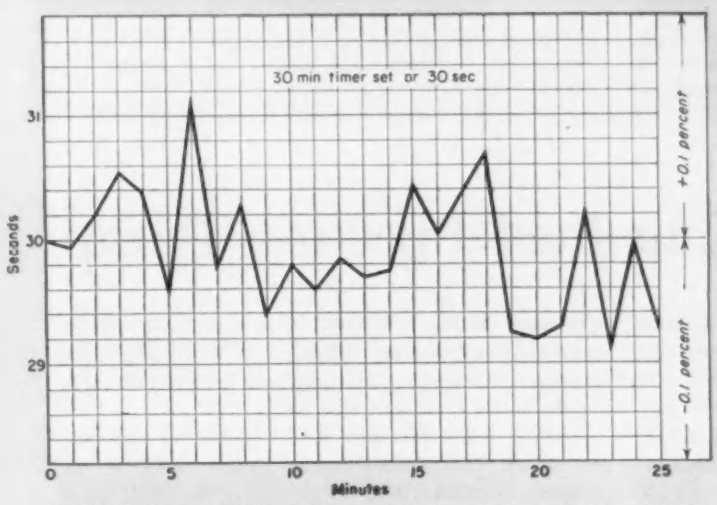




SIMPLE MECHANICAL FASTENING by retaining snap washers of the connecting rod to either end of the rocker arm allows the timer to be adjusted for either reset or non-reset upon power failure. Additional versatility is incorporated in the load switch assembly. Switching action can be adjusted by means of the small socket head screw on each switch, permitting the switch actuation points to be staggered around a given dial point.



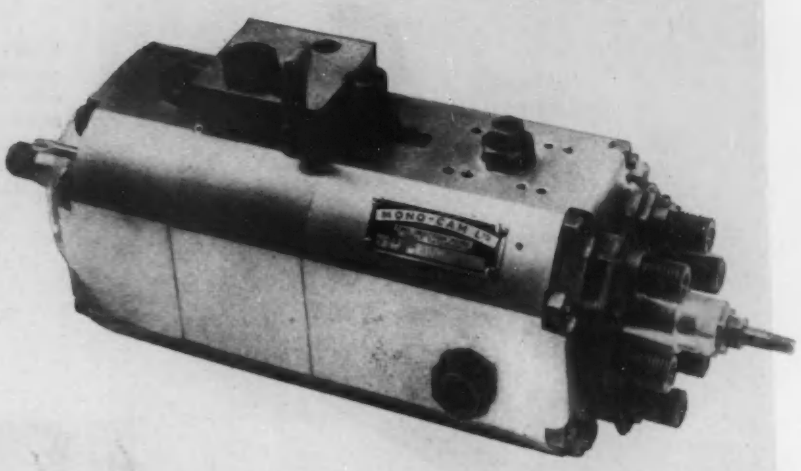
MOMENTARY or sustained starting circuit arrangements are obtained by external wiring variations through jumpers on the rear of the compression-molded glass fiber terminal block. This assembly is also designed for "plug-in" installation by simple removal of screw inserts at each terminal post. Since motor changing is necessary for different timing ranges, motor mounting requires only two bolts. In addition, block is designed to accept timing motors of three manufacturers.



MILLION-OPERATION TEST showed no discernible clutch wear. Plot shows clutch accuracy is well within 0.1 per cent of cycle maximum.

USE OF AN O-RING for the clutch surface, besides resulting in an inexpensive mechanism, permits the single tooth clutch to engage with sufficient "bite' to eliminate any possibility of slippage. Simplicity of coupling the motor drive and indicating pointer is achieved by using a single direct output shaft extended from the motor to the front of the chassis. The shaft drives a pinion and main gear, latter being directly fastened to the rotating clutch plate. To engage the clutch, a solenoid is energized which pulls the indicating pointer against the spring washer. Only a slight movement of the pointer is required to positively engage the bevel edge at end of pointer with O-ring.

COMPARED to conventional fuel injection pumps of equivalent capacity which weigh approximately 46 lb, Mono-Cam units weigh up to only 17½ lb. Dimensions range from 8 in. long by 3¾ in. dia to 10½ in. long and 4½ in. dia, depending on diameter of the elements.



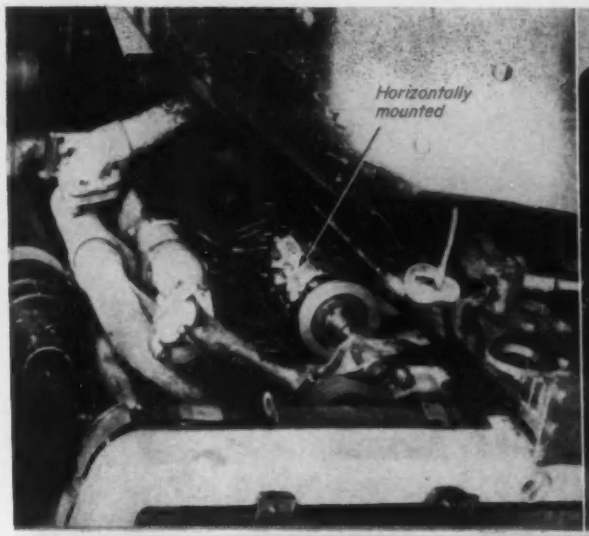
SERVICING of this single cam pump is relatively simple. For the stripping of the 6-cylinder unit shown here, with its combined hydraulic and pneumatic governor and fuel lift pump, no special tools are required. When re-assembled, the operator can random fit the pumping elements without affecting the delivery balance.

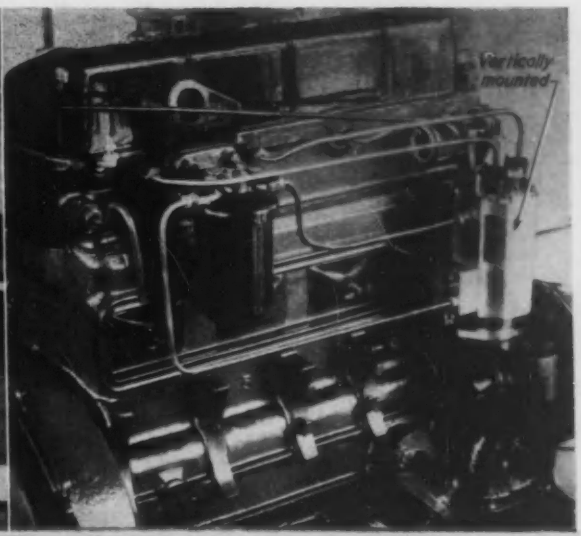
Single Cam Fuel Injection Pump

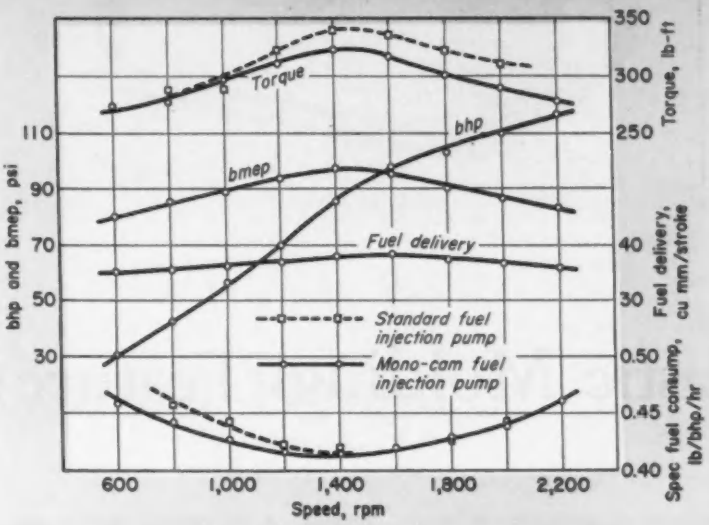
Designed around a single lobe face cam to operate individual pumping elements in rotation, incorporating either hydraulic or air-hydraulic governor control and having an integral fuel lift pumping unit, the new fuel injection pump developed by Mono-Cam Ltd., London, England represents a complete departure from conventional design.

The single cam design insures a constant and identical reciprocating motion to all plungers. The pumping units are also of novel design having no helix. This factor overcomes the loss of balance because of wear in helix control at low speeds and deliveries. With the single cam arrangement, the plunger is completely balanced throughout the entire speed and load range.

Another unusual feature is the overspeed governor mechanism. The pressure created by the "spill" of the pumping elements is used for governing the whole speed range. This is done by restricting the return of the spill to the feed side of the pump. Thus, the speed of the engine is directly controlled over the whole range with







PUMPS ARE SUITABLE for horizontal, flange or vertical mounting, the latter being a feature not possible with conventional fuel injection models. Also, the horizontal arrangement uses a standard mounting radius and is interchangeable with present fuel injection equipment.

PERFORMANCE CURVES for a 6-cylinder 2-stroke diesel engine show comparison between a conventional fuel injection pump and the Mono-Cam unit. Tests indicate that a distinct pilot injection occurs at 400 rpm, followed by a steady main charge ending with a sharp cut-off without after-injection. This gives smooth and quiet combustion over entire speed and load range.

Has Completely Balanced Plunger

the added feature of a sharp overspeed cut-in.

The feed pump when fitted forms an integral part of the injection pump. It is actuated by the main cam through a small roller and lever, the other end of the lever being available for hand priming. This arrangement has considerable effect on the cooling of the unit.

In operation, cam rollers in contact with the bevel face cam reciprocate the plunger in its barrel. Injections begins when the plunger covers the port holes in the barrel and it ends when the upward motion of the plunger causes a groove to leave a control sleeve. All the control sleeves are housed in a circular plate assembled as one member on a control shaft to which an axial motion is imparted by governing devices. Delivery valves are of the pressure relief type with flat seats.

Cam shaft is supported against the working load by a large diameter thrust face and ball bearings ensure complete rigidity. This type of shaft is comparatively free from the torsional vibration and bending deflections encountered in a conventional "in line" fuel pump.

. . . . *Blended Contours.* Integration of all components into a small brown phenolic cubical case with rounded corners makes possible the most compact arrangement of elements.

. . . . *Side Draws.* By utilizing a number of side draws in the dies, undercuts and holes are molded which otherwise would be impossible or would require secondary machining operations.

. . . . *Slide Locks.* Stamped metal clasps slide on molded undercut tracks to unlock camera for loading film and to clamp it tightly together again for use. Use of phenolic enables the clasps to slide smoothly for the life of the camera.

1900

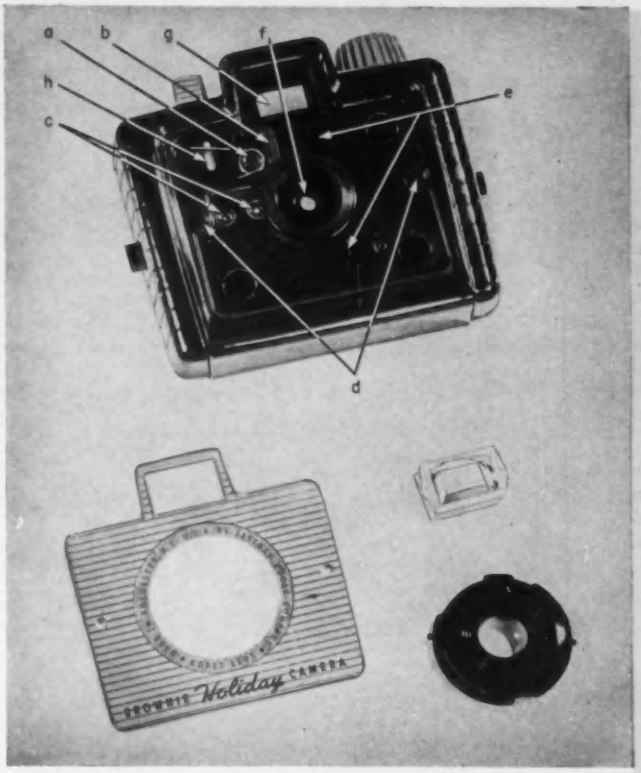
Plastic Moldings Feature

Engineers of the Auburn Button Works, Inc., Auburn, N. Y., collaborated closely with Eastman Kodak designers in the development of the new "Holiday" camera. While starting as a small garment button manufacturer over 75 years ago, the company today uses its facilities to produce plastic parts for industry by compression, transfer, injection, vacuum forming and rotary molding.

The engineers charged with designing the 1954 Brownie were given the same assignment that George Eastman had imposed upon himself a half century earlier—make a camera simple enough for a child to operate, one that will make the best possible pictures and sell at the lowest possible price. (New camera sells for $2.95 — 1900 model sold for $1.00.) However, to improve upon the value of a camera already highly developed over half a century through twenty previous models was a difficult order. Working with Auburn Button Works, Kodak engineers decided that the goal could best be achieved by following three basic principles: (1) Making maximum use of plastics to permit the integral molding of many additional features at no extra cost beyond the original dies; (2) reducing all secondary operations to a minimum, and (3) designing all parts with an eye on assembly time.

Three types of plastic are used in the Brownie "Holiday". Methacrylate was selected for the viewfinder lens because of its optical clarity and hardness. The lens mount, film-winding knob and shutter release button are molded of Tenite II because of its strength and appearance. Phenolic was chosen for the outer case and inner box because of its dimensional stability, moldability and resistance to temperature changes, scratching, chipping and breaking.

A perennial problem in camera design has been to find an ideal surface over which the film will slide without injury. Temperature, chemical action, static electricity and abrasion are critical factors. Phenolic plastic gives a very inactive and smooth surface for this purpose.



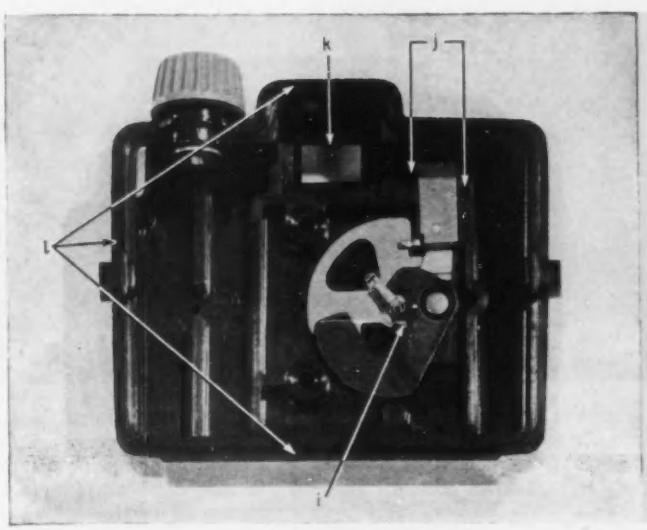
Camera Design

. . . . *Main Lens.* The use of a Tenite ring makes it possible for the lens to be "assembled accurate" instead of requiring individual adjustment as in expensive cameras. Since no two ground lenses are exactly alike in focal length, the lenses are 100 per cent inspected and sorted into several focal groups. Each group is similarly mounted in the lens holder ring, and therefore, preadjusted to provide the right focus position.

. . . . *Shutter Trigger.* To return the shutter button to position, a simple wire spring is placed over a molded stud where it is held by the face plate.

. . . . *Lens Lock.* The circular boss around the shutter opening serves as an accurate seat for the lens mount. The adjoining plastic rib (b) matches a slot in the lens mount to prevent it from revolving under the face plate.

. . . . *Pre-Molded Holes.* Nine openings shown in this view of case would generally have to be pierced by secondary operations if other materials were used. Here they are all molded simultaneously. Two knurled posts for inner shutter parts have already been driven from the rear into the two pre-molded holes (c) at left of lens opening. Two holes (d) are also formed for self-tapping face plate screws, and two more (e) for mounting the roll holder to front of case. Openings are also provided for main lens (f), viewfinder lens (g), and slot for trigger action (h). The single-operation molding of these various holes, ribs, studs, and undercuts saves machining and assembly costs.



. . . . *Simplified Shutter.* Reverse view of case front shows shutter to consist of only a spring and three metal stampings (i) riding on two brass axial posts that have been pressed into pre-molded holes. Two ribs from a track (j) for the push button while others increase the rigid strength of case. Note beveled frame (k) for viewfinder lens.

. . . . *Light-Tight Closure.* Molded ridge (l) around perimeter of case fits snugly into corresponding channel on other half, forming a light lock. This effective tongue and groove design would be expensive to form by any method other than molded plastic.

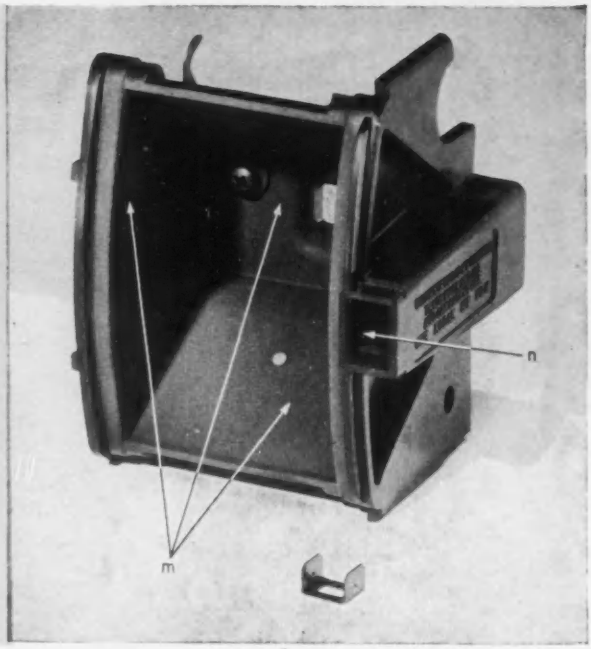
(Continued on next page)

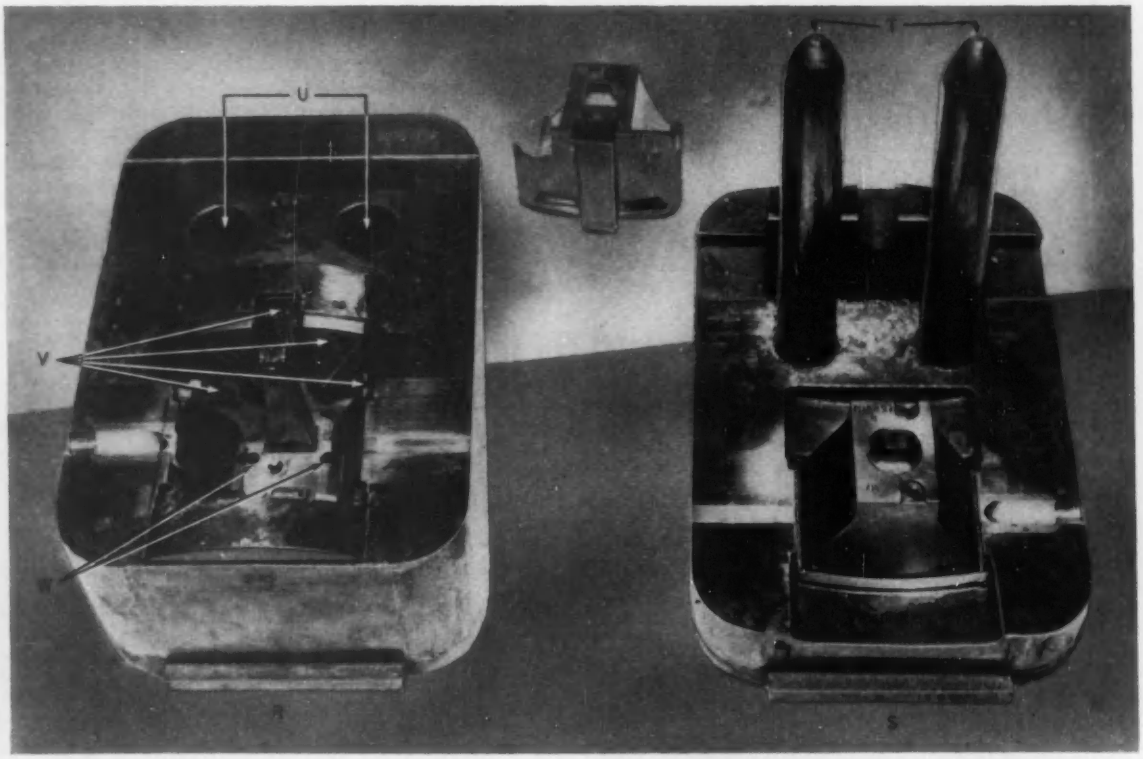
Camera (continued)

. . . . *Integral Viewfinder.* While earlier spyglass-type viewfinders were mounted separately, the finder is now incorporated into the case itself, making it less expensive to mount, and protecting it against damage.

. . . . *Non-Flare Box.* The separate roll holder box molded of black phenolic plastic is mounted within the outer case. The inside surfaces (m) of this box are sandblasted to remove the glossy surface of the plastic and prevent light from reflecting onto the film and producing flare spots in the picture. The roll holder incorporates the inner viewfinder cone. The interior walls of the viewfinder are also sandblasted to reduce reflections.

. . . . *Rear Lens Assembly.* Considerable saving of time was achieved in assembling the rear glass lens of the viewfinder. By molding tiny ridges (n) inside the eye piece, it is possible to simply snap the lens and stamped metal retainer into place.

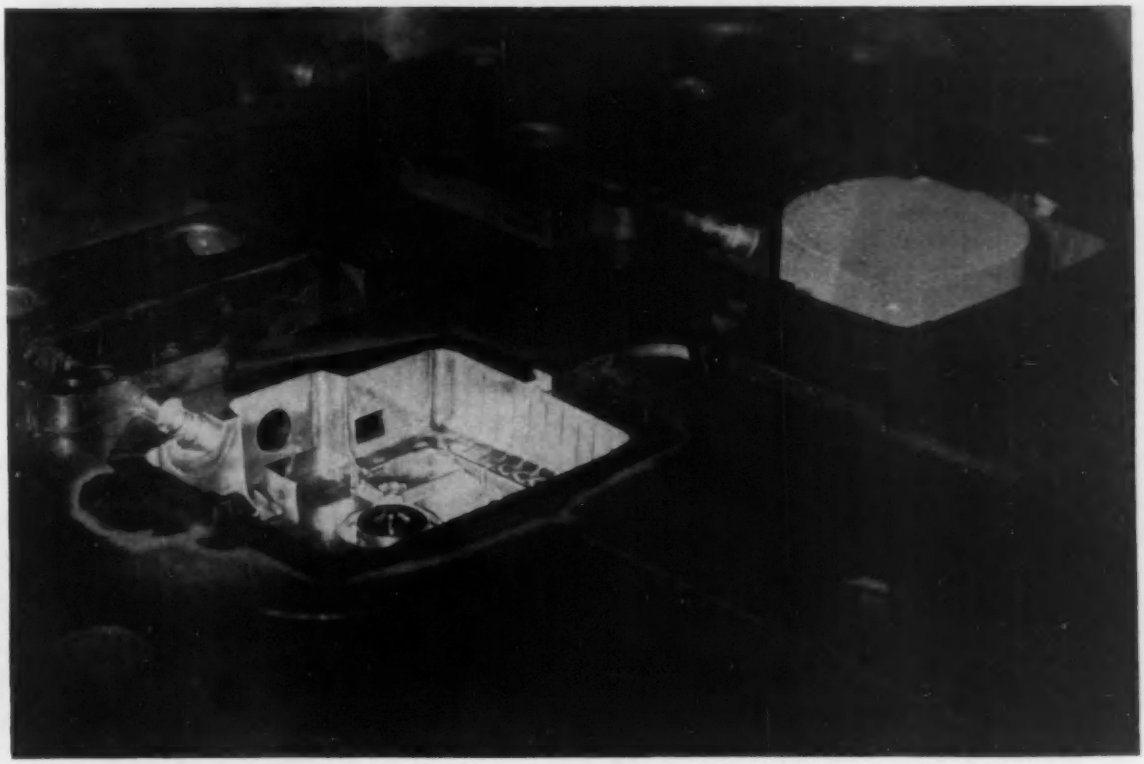




UPPPER AND LOWER HALVES of die used in transfer-molding of black phenolic interior roll holder box. Note side draw (u) at rear of cavity (r) on left. The two large steel dowels (t) in the mold (s) at right are set at an angle. When the press closes, these are forced into the two holes (u) in the side draw causing it to close just before the melted plastic enters through two holes (w) at bottom of cavity. When the press opens, the dowels pull the side draw back again, removing it from the undercut features (v) so that the complex plastic part can be removed from the die with a minimum of trouble.

. . . . *Side Draw Savings.* The coring of the roll holder box itself, the side recesses, tapering of viewfinder, hole for film winder shaft, and raised lettering which saves an extra printing operation, are all made possible by side draws in the die design. The entire box is formed in one molding operation.

. . . . *Assembly Savings.* Rear view of roll holder box shows how the two spring-metal clips (o) at right for holding the film roll and take-up spool are designed in a one-piece T-form stamping for economical assembly. This part is fastened to the box with a single rivet (p) and kept from rotating on the rivet by the plastic stop (q). This method of simplifying an assembly operation is made practical through the use of molded plastic because the key stop can be formed at no extra cost along with the rest of the box. A similar technique is use for the small spring-metal clip (r) located just above the lettering. The pressure of this clip against the film spool prevents it from unwinding.



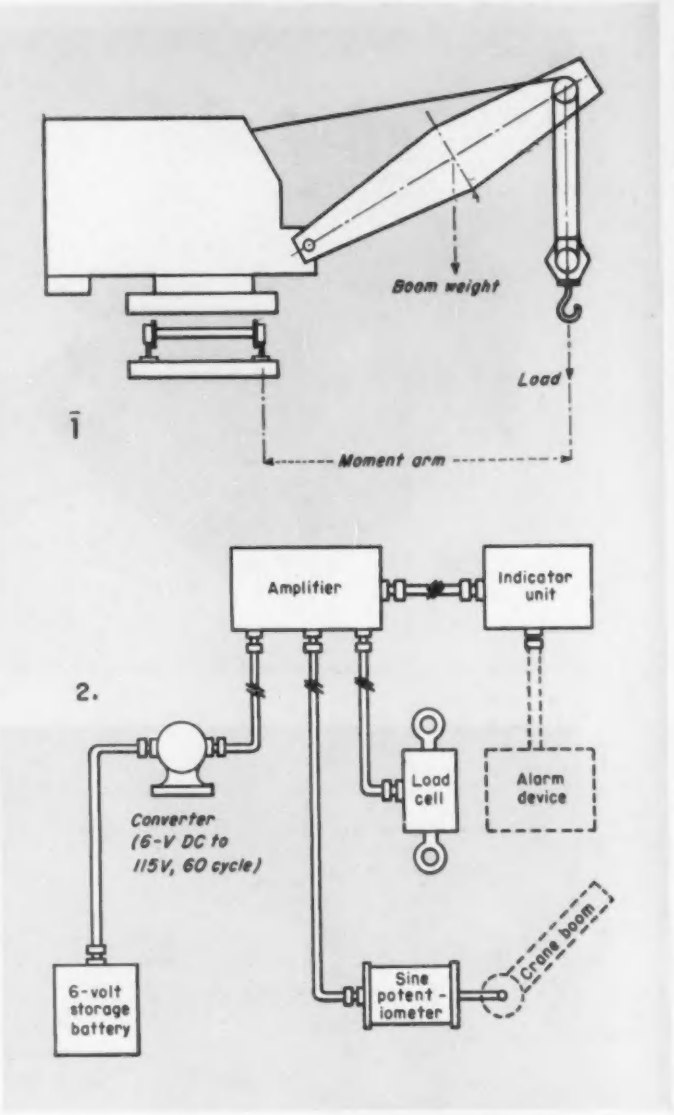
VIEW OF DUPLICATE CAVITIES, each of which pressure-molds a front section for a camera. These polished chrome-plated steel dies are shown mounted in the lower cavity retainer plate in the press. At right is a preheated brown phenolic plastic preform which is placed in each cavity before the press closes. Another side draw can be seen behind each of these cavities. This draw has a travel of $\frac{5}{8}$ in. The curing cycle in the press is $1\frac{1}{4}$ min. The plastic part is then removed and placed in another fixture to cure for $2\frac{1}{2}$ min more, rather than up press time by leaving it in the die to cure completely.

A Crane-Tilt Alarm System

A recent development out of the U. S. Naval Gun Factory, Washington, D. C., is an alarm system for automatically warning an operator whenever his crane is in danger of exceeding its tilt limit.

Developed by Leon Scharff, this system is aimed at eliminating damage to equipment or injury to personnel caused by operator carelessness or overestimation of the crane's load capabilities. The equipment consists of two principal sections—a moment computer and alarm indicator. The computing section takes the weight of the load and the angle the boom makes with the horizontal to electrically compute the moment arm. This computed moment is then sent as an electrical signal to a servo system which feeds the amplified signal to an indicating meter. At moment settings pre-set for the particular crane by positioning precision switches, the servo motor mechanically actuates the switches to sound the alarm and set-off a flashing red light.

Although originally designed as an alarm system, the equipment is presently being modified to also incorporate an interlocking arrangement. This would act as an added safety feature to prevent the boom from lowering should the warning signals be ignored. Further development will probably see the servo-indicating system replaced by a direct-reading voltmeter arrangement built around electrically actuated relays for energizing the alarm and interlock systems.

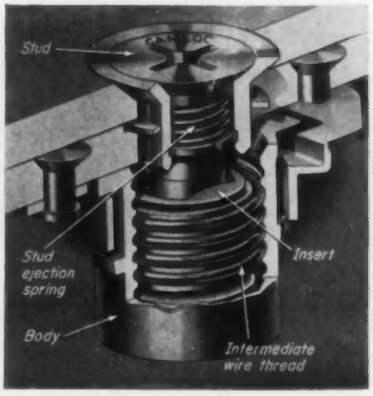


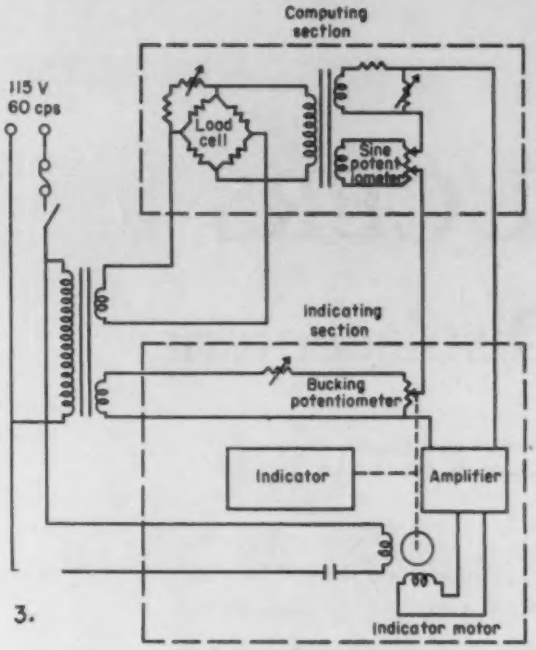
Quick Opening Fastener Has Persisting Torque Feature

Designed for highly stressed panels such as those found on high-speed aircraft and missiles of various types, new Camloc SPF fastener has high persisting torque life, and the quick-operating feature of a quarter-turn fastener. Contributing to the long torque life is an intermediate wire thread between the insert and body into which are built controllable frictional characteristics. Wear on moving parts is therefore reduced, as only about a three-quarter turn of the stud completely locks the assembly.

When the stud is rotated the first 90 deg, stud shoulders engage two shelves within the insert. As stud continues to turn, torque of its shank is transmitted to the inside wall of the insert which then rotates with the stud and is screwed down on the intermediate wire threads.

"Flag" action of the stud assures that only the proper length is used; if too long or too short a stud is used, it will not





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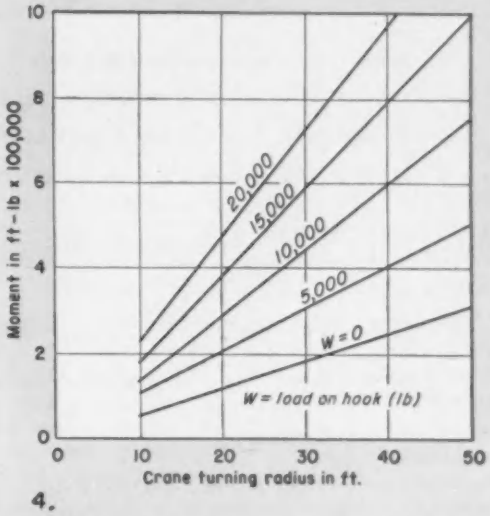
1. Initial application for the tilt-warning equipment is on railroad type cranes. However, system can be easily adapted to other types of cranes having different boom lengths and load capacities in a variety of fields.

2. Overall system is packaged in a number of small interconnected units. Amplifier, converter and indicator are housed in the crane cab with the meter located in full view of the operator. Boom angle measuring sine potentiometer is attached to crane boom pivot pin; load cell is attached to crane hook or tied in with lifting cables.

3. System requires 50 w for its operation, the power being supplied by the crane's 6-v storage battery. The computed moment of the loaded boom is transmitted to the indicating section of the equipment as an electrical signal whose amplitude is a linear function of the actual moment.

4. The indicator meter gives the operator a visual check on the actual moment computed by the system as illustrated by this chart. At predetermined moment settings, the alarm system consisting of a buzzer and flashing red light is actuated.



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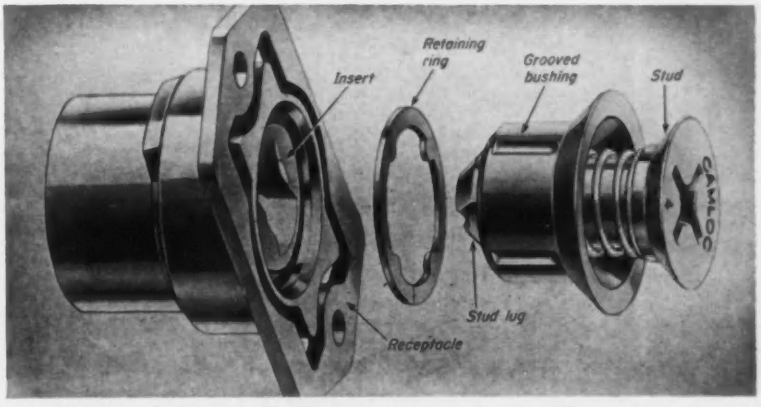

fasten. Since the bushing takes all shear loads, the stud is free to be popped up by the ejection spring.

High vibration resistance of the stud is assured since it is held in the fastened position by a spring-loaded detent plate which mates with bottom face of stud lug.

Fastener requires a $\frac{1}{8}$ in. instead of a $\frac{1}{4}$ in. hole for mounting because of the internal construction. Laboratory tests made for the manufacturer, Camloc Fastener Corp., of Paramus, N. J., show that the $\frac{1}{2}$ in. edge distance used with a $\frac{1}{4}$ in. hole can be retained with the $\frac{1}{8}$ in. hole without endangering shear strength of the plate. Insert is free to "float" in receptacle permitting leeway in installation tolerances.

TRANSDUCERS

For Measuring Displacement, Velocity, or Acceleration

Influence of motion characteristics, required accuracy, and desired form of results on transducer selection. How mounting method, accessibility of motion, and dynamic and electrical characteristics of transducers determine type to use. Devising transducers when available units are not suitable.

SIX FACTORS GOVERNING MOTION-TRANSDUCER SELECTION

1. Maximum expected value of displacement, velocity, or acceleration.

2. Frequency of the displacement, velocity, or acceleration. If the motion is not harmonic, the effective frequency should be determined. If the displacement, velocity, or acceleration to be measured has a very steep wave front, even though the cyclic frequency may be low, the effective frequency may be several times higher.

3. Required accuracy. Instrumentation should be selected to give the accuracy sufficient for practical purposes. Increased accuracy usually adds unnecessary instrumentation and man-hour costs to project.

4. Effect of transducer loading on system being measured. Accuracy may not be sufficient if characteristics of the system under measurement are affected by transducer loading.

5. Accessibility of the motion to be measured. Amount of space available for applying suitable pickups may be limited.

6. Desired form of results. Measurement results should be in a readily useable form. For example, although acceleration can be obtained by measuring displacement and either by graphical or electrical means differentiating twice, it is simpler to measure acceleration directly.

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FOR MEASUREMENT of displacement, velocity, or acceleration in product design or testing, a wide variety of transducers is available. Choosing a transducer requires detailing the six factors outlined above. The method of mounting and excitation, and the mechanical, dynamic, and electrical characteristics of transducers on hand must be considered. Should the measurement be likely to damage a costly unit, or a suitable one be unavailable, instrumentation can often be devised.

MOUNTING. Among transducers applicable to the measurement of displacement, velocity, or acceleration are the following principal types: magnetic, resistive, capacitive, piezoelectric, photoelectric, and radioactive. Many of these transducers may be mounted in two ways. In the first method the motion-sensitive portion of the pick-up is directly actuated by the motion to be measured, and a positive reference point is therefore available, as shown at (A) in Fig. 1. In the second or seismic-mass method the transducer base is fastened to the vibrating body, and the motion-sensitive element is actuated by seismic mass movement, as shown at (B). Depending upon transducer design, either method of mounting can produce a signal proportional to displacement, velocity, or acceleration.

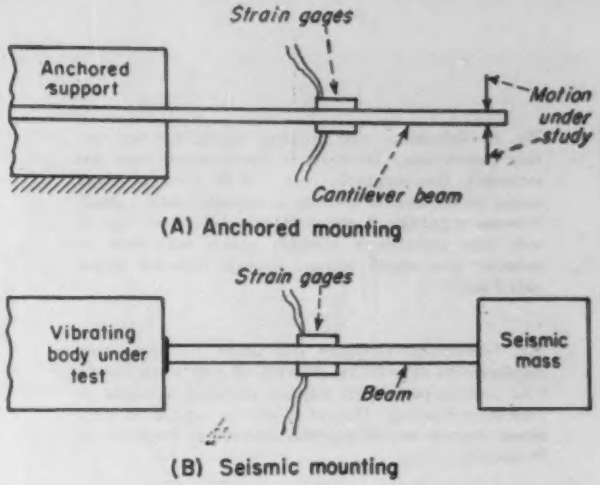


Fig. 1—Two methods of mounting transducers. (A) Anchored support rigidly holds one end of cantilever beam. Strain-gage transducers are fastened to beam. Motion under study actuates free end of beam, varying resistance of gages. (B) Seismic mounting. One end of beam is fastened to vibrating body under test. Motion of seismic mass at opposite end of beam produces changing signal in transducers.

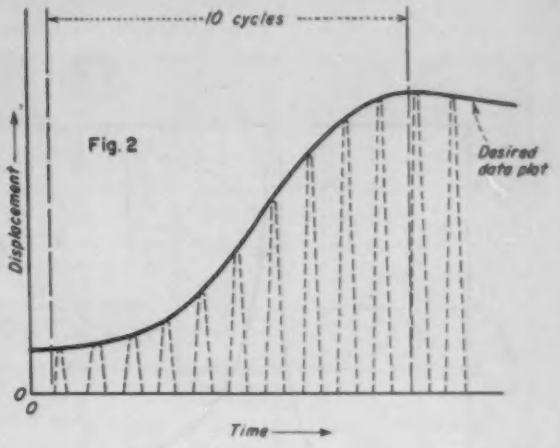


Fig. 2—Selecting carrier frequency for excitation of transducer. Approximately 10 cycles of carrier should be contained within steepest portion of motion wave-front being studied. Negative portion of carrier has been omitted.

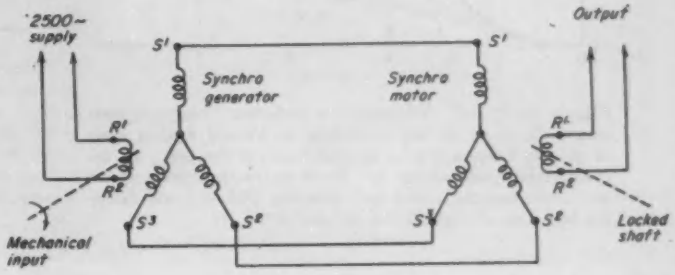


Fig. 3—System for measuring angular displacement using synchro generator and motor. These units are connected as shown and excited by 2500-cycle supply. Mechanical input is applied to rotor of synchro generator. Rotor of motor is locked, and output is taken from locked winding.

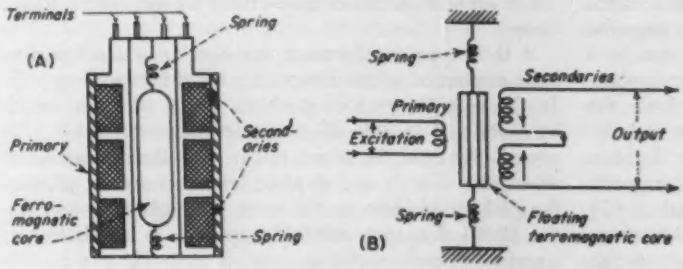


Fig. 4—Differential transformer assembly details and circuit diagram. (A) Ferromagnetic core is suspended on springs midway between two secondaries. Connections to primary and secondaries are brought out to terminals. (B) Excitation is applied to primary, and with zero motion, equal and opposite induced voltages in secondaries buck each other, producing zero output signal. When core is displaced, induced secondary voltages become unequal, and a signal appears across output terminals.

EXCITATION. Except for the permanent magnet and piezoelectric type of transducer, all others discussed here can be energized by d-c or low or high frequency a-c carrier current. In order to obtain accurate response, frequency of the carrier used should be at least 10 times the fundamental frequency of motion to be measured. For simple harmonic motion, frequency of the energizing carrier is a simple multiple. If the motion has an abrupt change, even though the fundamental frequency is low, the effective frequency may be high. In this case the carrier frequency used should be as high as in Fig. 2.

MAGNETIC TRANSDUCERS. Magnetic transducers are commonly used for motion measurements. This group includes generators and variable-reluctance devices. An example is the tachometer generator which produces a voltage proportional to the angular velocity of its shaft rotation. This unit applies a fair amount of load to the system and is not usually adaptable to measurement of light, small, or sensitive systems.

In the variable-reluctance transducer, reluctance of the unit is changed by varying the length of the air path through which magnetic flux passes. Perhaps the best known of the reluctance pickups is the differential transformer in which a ferro-magnetic core is moved inside a primary and two secondary windings placed as shown at (A) in Fig. 4. The center or primary winding is used for excitation, while the two secondaries are connected so

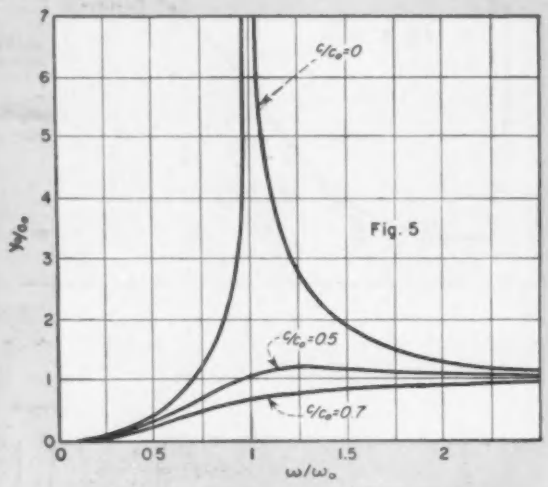


Fig. 5—Ratio of differential transformer magnetic-mass amplitude y_o to driving amplitude a_o plotted against ratio of driving frequency ω to natural resonant frequency of the spring-mass combination ω_o. Three curves indicate relative amplitude variations with zero damping $c/c_o = 0$ and damping less than critical $c/c_o = 0.5$ and 0.7.

Fig. 6—Reluctance-type inductor transducer and circuit connections. Inductor is center-tapped and has moveable ferromagnetic core. With core on dead center potentiometer resistor is adjusted until voltage between terminals 2 and 5 is zero. Displacement of iron core unbalances voltages across each half of inductor and signal voltage appears between terminals 2 and 5.

Fig. 7—Permanent-magnet transducer for measuring displacement or velocity. Motion of gear teeth distort field around permanent magnet, inducing voltages in multiturn winding. Output of coil is applied to electronic counter which registers number of impulses or frequency.

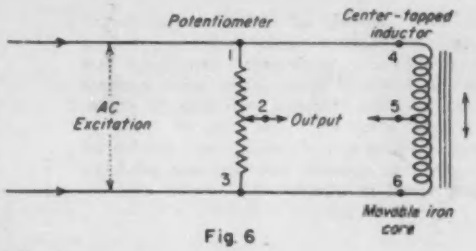


Fig. 6

that their induced voltages buck each other as indicated at (B). With the magnetic core exactly centered, no signal is received from the secondary windings. When the core is moved in either direction, reluctance of one end increases, the other decreases, and an output voltage appears between the outside terminals of the secondaries. If the magnetic core is mechanically coupled to the transducer case by a spring, as shown at (A), it can be used to measure displacement, velocity, or acceleration depending on both the resonant frequency of the spring-supported core and the d-c or a-c excitation of the center winding. Fig. 5 shows (1) the ratio of the amplitude variation of the magnetic mass y_o to the driving amplitude q_o plotted against (2) the ratio of the driving frequency ω to the natural resonant frequency ω_o of the system. The three curves indicate the amplitude variations obtainable with no damping $C/C_o = 0$, and progressively heavier damping $C/C_o = 0.5$ and 0.7.

When this transducer primary is energized with ac, the unit can measure acceleration at frequencies up to one-half resonant frequency $\omega_o/2$ and displacements at frequencies over twice the natural frequency $2\omega_o$. The transducer, if excited with a dc voltage can produce a signal proportional to the rate of change of acceleration at frequencies less than $\omega_o/2$; and at frequencies above $2\omega_o$ the signal will be proportional to velocity. Thus, by varying both the natural frequency of the spring-mass system and the type of excitation, it is possible to produce a signal proportional to any of the three parameters of motion. In addition, this transducer requires no datum point.

A second type of reluctance transducer is a center-tapped single-winding inductor in which the length of the flux path or air gap is changed by movement of a magnetic core or armature. A-c excitation is applied to the winding and an output taken from between the center tap of the inductor and the center tap of a resistor connected across the excitation, as shown in Fig. 6. The output voltage is proportional to the core displacement, but is lower than that obtained from the differential transformer.

A third type of reluctance transducer is a small permanent magnet on which is wound a multi-turn pick-up coil. In this case the magnet produces a field which is varied by motion of an external magnetic body near which it is placed. An example, shown in Fig. 7, is the measurement of angular velocity and displacement obtained by placing the pick-up adjacent to the teeth of a gear and feeding the electrical output, suitably amplified, to an electronic counter. These counters are accurate up to $10^6 \pm 1$ counts per second, and the combination produces highly accurate measurements. Since the permanent-magnet pickup output is proportional to rate-of-change of flux, the voltage output increases in proportion to the angular velocity of the gears. This type transducer is useful in studying motions of light magnetic devices since it imposes negligible loading.

In measuring angular displacement, application has been found for a combination of synchro generator-motor magnetic transducers. In use, the rotor of the synchro-generator is energized by a 2500-cycle oscillator, as shown in Fig. 3. The rotor of the second synchro is locked and the output voltage appears across the terminals of this rotor. This system has a frequency response of 10 cps. In addition, an angular phase shift between input and output may be obtained by turning the locked rotor to a new fixed position. It should be noted that the possibility of a 180 deg ambiguity exists with regard to phase.

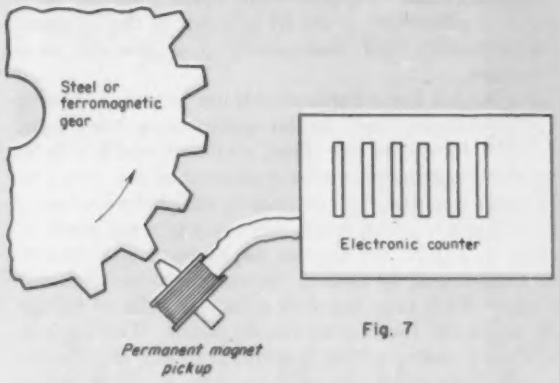


Fig. 7

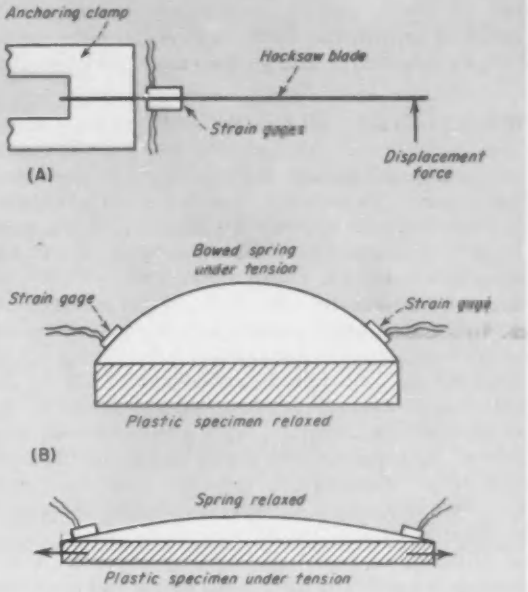


Fig. 8

Fig. 8—Using strain gages to measure large displacements. (A) Clamp anchors one end of hacksaw blade on which strain gages are mounted close to clamp. Displacement is applied to free end of hacksaw. Up to 3 in. can be measured satisfactorily. Response is limited by natural frequency of cantilever system. (B) Measurement of elongation of plastic under tension. Bowed spring has strain gages fastened to each end. When plastic stretches under tension, indication is provided by reduced strain in bowed spring. Elongations up to 30 per cent may be measured accurately.

RESISTIVE TRANSDUCERS. Resistive transducers fall into two major categories. In the first, a change in resistance is obtained by a linear or rotary motion, and in the second the change is obtained by compression or tension of the resistive element. A potentiometer is an example of the first type, a strain gage of the second. Both types use either a carrier frequency or d-c excitation.

Potentiometers are available with movable center arms which can be operated with a back-and-forth motion or with a radial motion. The choice for a particular application depends upon the type of measurement to be performed and excursion of the motion.

The potentiometer is limited to approximately 10 cps operation, as the potentiometer follower begins to bounce at higher frequency. However, below this frequency, linear and rotary-actuated potentiometers are capable of indicating large displacements.

Strain-gage transducers generally have excellent frequency response in both low and high frequency ranges. Strain gages can be applied to measure displacement in several ways, but some difficulty is encountered in measuring large displacements. Strain gages mounted on hacksaw blades can be used to measure relatively large displacements where expensive pickups may be subject to damage. The blade is used as a cantilever with the strain gage or gages at the fixed end, as shown at (A) in Fig. 8. The frequency response of this device is limited by the natural frequency of the cantilever system. Deflections larger than 3 in. are difficult to measure accurately by this method because nonlinearities in the strain-displacement relationship occur. One method by which this disadvantage can be overcome is to use strain gages mounted on both ends of a spring formed into a bow. In a practical application the extension of plastic parts is measured by mounting them in a tension machine and attaching the bowed spring and strain gages as shown in Fig. 8. The strain in the plastic is indicated as a greatly reduced strain in the bowed section. Elongations up to 30 per cent may be measured accurately.

An unusual type of strain gage, useful in measuring large deflections, consists of a rubber tube, 3 to 6 in. long, with an inside dia. of 0.004 to 0.008 in., filled with mercury. Electrical connections are made to the mercury column by copper wires which also seal the ends of the tube. The tube is folded back and forth on itself in a manner similar to the resistance wire in a strain gage. Strains varying sinusoidally from 0 to 50 per cent at frequencies of 12 cps can be measured over several thousand cycles without requiring recalibration and without signal distortion.

CAPACITIVE TRANSDUCERS. Capacitive transducers consist essentially of two conductors separated by a dielectric or insulating material. The capacitance is a function of separation between conductors, area of the conductors, and dielectric constant of the insulating material between them. Changing any of the three parameters produces variations in capacitance which may be accurately calibrated and used for motion analysis. High-frequency response, small to large displacement ranges, excellent resolution and ability to measure a static quantity are characteristics of capacitance transducers. Accurate and reproducible spacing of the electrodes is required and this spacing must be maintained if the calibration is to be consistent. In addition, the variation of capacitance in the input leads to the pickup must be kept low.

An example of capacitive transducer use is in measuring

the displacement-time relationship of an automatic coil-winding wire-distributing arm. The transducer consists of a cylindrical metal rod moving in and out of a hole in a block of metal, converting reciprocating motion into changes of capacitance. Using this system, measurement of large displacements with good accuracy can be effected.

PIEZOELECTRIC TRANSDUCERS. A piezoelectric crystal produces an electrical potential whenever the dimensions are changed through the application of mechanical force or stress. Piezoelectric crystals used in transducers are: quartz, tourmaline, Rochelle salts, and barium-titanite. The natural crystals (tourmaline, quartz) have very low leakage which, when used with electrometers of high output, permits measurement of slowly varying pressures and forces. In addition, they can withstand higher temperature and mechanical shock. Synthetic crystals (Rochelle salts, barium-titanite) have a much higher output for given displacements, stresses, or pressures, but are usually unable to withstand high mechanical strain without fracture. Also, synthetic crystals deteriorate rapidly at elevated temperatures. Of the synthetics, barium-titanite can be formed into numerous shapes which makes it adaptable for special-type transducers. In general, piezoelectric pickups have the advantage of good high-frequency response. A disadvantage is a relatively small signal output and sensitivity to vibration and temperature change.

PHOTOELECTRIC TRANSDUCERS. Gas, high-vacuum, and multiplier phototubes can be used as transducers. Gas and high-vacuum types are similar in characteristics but vacuum phototubes have a higher frequency response and are less sensitive than gas filled. The photomultiplier tube, by means of a series of electrosurfaces called dynodes, amplifies cathode current produced by light, acting as both a transducer and amplifier. The signal obtained from multiplier phototubes is usually sufficient to operate many devices directly, and consequently it is desirable as a transducer.

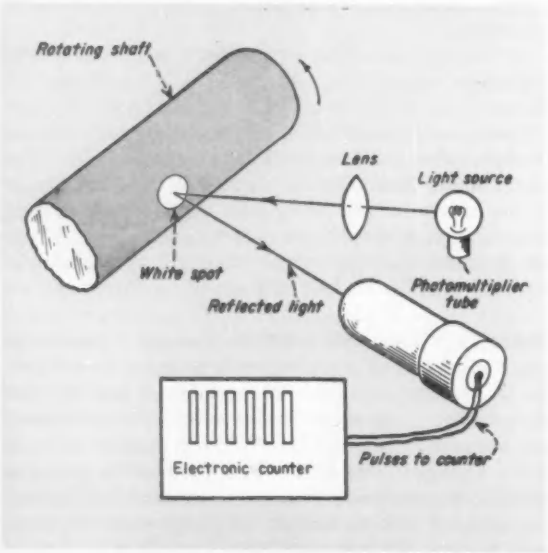


Fig. 9—Photoelectric transducer used to measure displacement or velocity of shaft or attached or connected parts. Light beam from light source is focused on white spot on rotating shaft. Each time shaft rotates reflected light strikes photomultiplier tube and an output pulse is developed which is fed, through proper circuits, to an electronic counter. Counter can be set to register total number of pulses between two given times, or measure frequency of shaft rotation directly.

Angular and linear displacements can be measured using a photo-multiplier tube. In this application, a strong point of light is focused on the object, motion of which is to be measured, and the phototube is directed at this spot. As the object is moved, light received by the phototube varies. If the object is a shaft which has a spot of white paint, as shown in Fig. 9, the angular displacement and velocity can be obtained by feeding the output to an electronic counter. Each time the shaft rotates, a pulse of voltage will be sent to the counter and registered. This setup is particularly useful where the system under test cannot stand loading. One of the disadvantages of this system is the complexity of the equipment required for such measurements. Depending upon the phototube being used, an additional amplifier may be required to bring the level of the voltage up to the magnitude required to operate the counter.

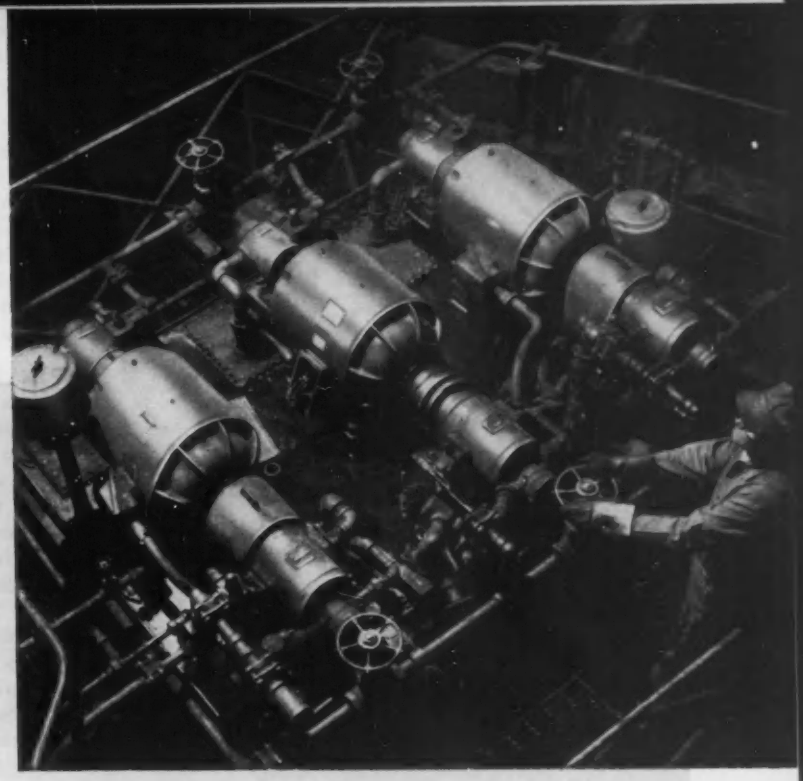
RADIOACTIVE TRANSDUCERS. Radioactive transducers usually consist of an ionization chamber, such as the Geiger counter. Radiation effects vary in proportion to the distance between the source and counter, and it is possible to measure displacement by placing a radioactive source on the moving part and measuring radiations reaching the Geiger counter. This system is useful in cases where a suitable transducer cannot be mounted on the part to be measured or where leads from the transducer cannot be brought out to recording instruments. An example of radioactive transducer use is in measuring rotation of a piston inside a closed cylinder. A small particle of radioactive material is placed in the skirt of the piston and a Geiger counter located outside the cylinder wall. Using the proper circuitry, a voltmeter pointer deflection can be obtained for each rotation of the piston. Circuits of this type using a high-speed counter have been designed to measure rotational speeds up to 25,000 rpm.

EDITOR'S NOTE: The next in this continuing program of articles on instrumentation in product design and development to appear in a coming issue, will describe recording systems, their characteristics, application and use. Three earlier transducer articles listed here have included data of special value in product testing.

"Pressure Transducers" (Jan. 1954, p 174) discusses the application of resistance strain gage, capacitance, piezoelectric, and reluctance-type transducers for pressure measurements, with emphasis on high-temperature transients. Advantages and disadvantages of each type are summarized.

"Strain Gage Transducers for Measurement and Control"—a 28 page special feature (Nov. 1952, p 121)—is a comprehensive article on resistance strain gages. The first section describes bonded and unbonded gages, types of bridge circuits, amplifying and recording equipment, and systems combining these components. Remaining sections discuss various types of strain-gage transducers used for measuring pressure, flow, weight, and displacement. Case histories are included.

"Ready-Made Amplifiers for Transducer Signals" (Sept. 1951, p 143) explains advantages and methods of using standard temperature controller-recorders as transducer signal amplifying and recording instruments. Summary of transducer characteristics for acceleration, motion, speed, radiation, density, pressure, humidity, frequency, force, weight, temperature, radiation, current, and power-sensitive measurements is included.



HYDRAULIC POWER-PACK for operating a loading boom to move billets at 2,250 F in and out of a rotary steel furnace at National Supply Co.'s Spang-Chalfant plant. Use of a synthetic fire-resistant fluid assures maximum protection against damage to equipment or injury to personnel.

Synthetic Hydraulic Fluids

Compared to petroleum oils, synthetic fluids are more expensive and may attack certain packings, seals and machine paints. But they are fire-resistant and superior in lubrication, compressibility, non-corrosiveness, mechanical and chemical stability, and can be reclaimed.

J. S. HARRIS
Organic Chemicals Division
Monsanto Chemical Company

MAJOR REASON FOR USING the more expensive synthetic hydraulic fluids instead of the conventional petroleum based oils is their fire-resistant characteristic. To decide whether a fire-resistant fluid is necessary and if so, which type will best fit the job requirements depends on: (1) Characteristics of the fluids; (2) how the fluids differ from petroleum oils; and (3) what must be considered in the design of equipment using them.

A hydraulic fluid can be made fire-resistant in two ways: First, a liquid can be made less flammable by adding a "snuffer" agent to it. The water-based fluids such as Ucon Hydrolube (Carbide and Carbon Chemical Corp.) and Houghton-Safe 271 (E. F. Houghton Co.) are examples of this type, being previously discussed in "Which Characteristics for Hydraulic Fluid", *Product Engineering*, August 1953, page 149. The second method is to develop a material which is resistant to burning because of its chemical nature or composition.

Two classes of chemicals belonging to the last category of materials have reached commercial importance: phosphate esters and chlorinated hydrocarbons. Examples of the first class are Pydraul F-9 and tricresyl phosphate made by Monsanto Chemical Co. Tricresyl phosphate is also manufactured by the Celanese Corp. under the trademark Lindol HF and by Ohio Apex. Aroclor chlorinated biphenoyl, an example of the second type, is also made by Monsanto.

Fluid Characteristics

FLAMMABILITY. There are few materials, including metals, that under the proper conditions cannot be made to burn, and this includes the fire-resistant fluids. What is more important in the use of hydraulic fluids is whether they will burn when not in contact with a high temperature source, such as a motor, hot metals or a flame. Will the fluid run down the front of a furnace and carry the flame to the floor and across it, or down the sides of a die pot and spread back to the broken line? If a spray is broken up into a mist, will the mist be flammable? The heart of the matter is whether the fluid will

Table I—Timken EP Test

	OK Load (lb)	Film Strength (psi)
Tricresyl Phosphate	35	17,000
Aroclor 1248	25	11,200
Pydraul F-9	45	17,500
Typical petroleum oil	less than 5	seized

Table II—Shell 4-ball Wear Test

	Scar Diameters (mm)			
	Steel on Steel		Steel on Bronze	
	1 kg load	40 kg load	1 kg load	40 kg load
Tricresyl Phosphate	0.14	0.52	0.46	1.03
Aroclor 1248	0.38	0.73	0.45	0.81
Pydraul F-9	0.16	0.70	0.30	1.08
Typical petroleum oil	0.20	0.80	0.96	2.71

burn under the conditions of actual use and spread the flame into areas in which are not provided with high-temperature protection.

There is no single test that can be taken as a measure of flammability of a fluid under conditions of use. Flash point and fire point which have been used for many years by the petroleum industry as a control test in their distillations, are not meaningful in the determination of flammability. The best accepted tests are those based upon some of the military specifications, such as MIL-F-7100, which simulate conditions that might be encountered in the use of the fluid. These tests include spraying at a high pressure through an oxyacetylene torch, dripping on a hot manifold and spraying over a burning rag.

The fire-resistant fluids now commercially available have all been developed by the use of tests of this nature, and have been in field use for a number of years. During this time there have been many cases of line breaks and spills where the fluids have been dumped on molten metal, over red-hot ingots and sprayed into furnaces through flames. In no case has combustion been sustained. Thus, it appears that the laboratory flammability tests do have a valid relationship to actual use.

LUBRICATION. Perhaps the most important characteristic of a hydraulic fluid, certainly one of the most important with relation to equipment design, is its ability to lubricate the pump and other moving parts of the system. The synthetics are outstanding in this regard.

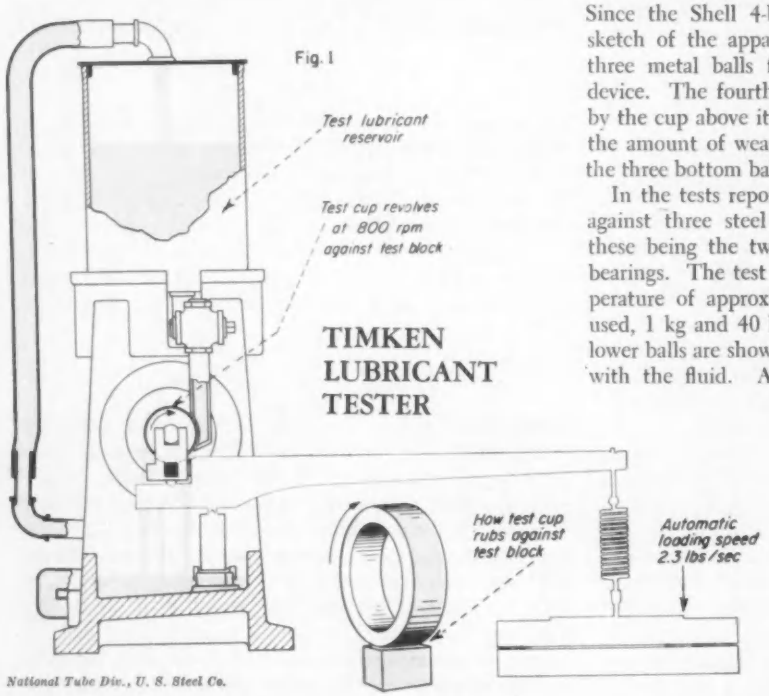
One of the most commonly used tests to determine the film strength and extreme pressure characteristics of lubricants is that developed by the Timken Roller Bearing Company which is called the Timken Extreme Pressure Test. Fig. 1 shows a sketch of this apparatus. The lubricant, shown in color, is pumped up into the reservoir and allowed to flow down over a ring which rests on a block, the ring and block being shown separately to illustrate this concept. Pressure is applied by a weight and lever to hold the block against the ring under a given load while the ring is rotating. By increasing the load, the point is determined at which the lubricant will break down and allow the two metals to come into direct contact. The OK load is considered to be the load 5 lb. below that at which scoring occurs. By measuring the area of the scar, the actual film strength of the lubricant in psi can then be computed. Table I shows the results obtained with the synthetic fluids as compared to a typical petroleum fluid. Note that the film strengths of the synthetics are much higher, the petroleum fluid seizing at less than 5 lb., the lowest test weight used.

To measure the anti-wear characteristic of a lubricant, the Shell 4-ball and the Almen tests can be employed. Since the Shell 4-ball is most frequently referred to, a sketch of the apparatus is shown in Fig. 2. There are three metal balls fixed in place at the bottom of this device. The fourth ball is placed on top and is revolved by the cup above it. The load is applied from below with the amount of wear measured by the size of the scars on the three bottom balls.

In the tests reported in Table II a steel ball was tested against three steel balls and then against bronze balls; these being the two most commonly found materials in bearings. The test was run for 1 hr at 600 rpm at a temperature of approximately 170 F. Two test loads were used, 1 kg and 40 kg. The diameters of the scars on the lower balls are shown in mm and are a measure of the wear with the fluid. All of the straight synthetics show up very well, and even at the very high load are comparable to the petroleum oil. Some lubricants allow the balls to weld to each other at much lower loads.

Another test used to measure the amount of wear with different lubricants is the Almen Wear Test. This can be described as consisting of a split bushing which is clamped to a shaft of a larger diameter under

Fig. 1



National Tube Div., U. S. Steel Co.

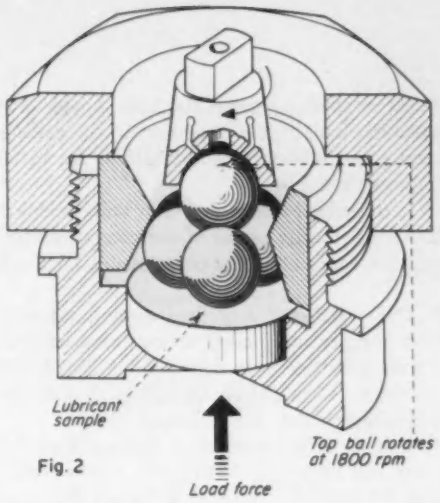


Fig. 2

National Tube Div., U. S. Steel Co.

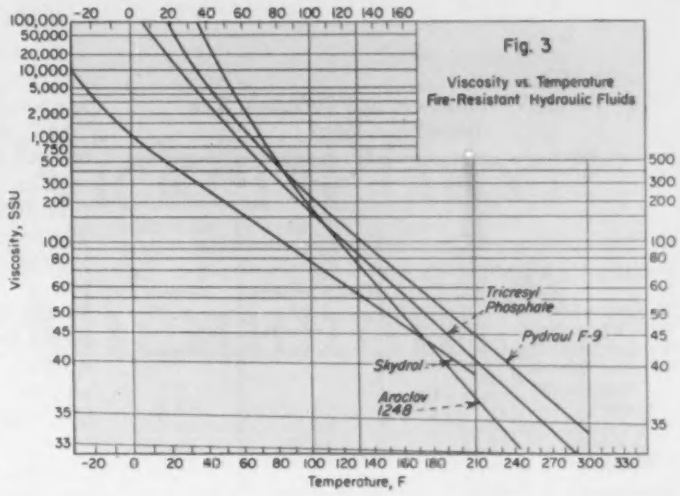
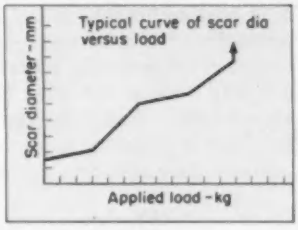


Fig. 3

Scar diameters are measured horizontally and vertically



Load scar curve

Test is concluded when weld occurs

PRECISION-SHELL 4-BALL TESTER

pressure. The shaft is rotated at a constant speed, and the sleeve is then weighed to determine the loss of metal resulting from wear. Table III shows the results of this test. The load was 4000 psi and the shaft speed 600 rpm. Wear is reported in milligrams of metal lost during the 20 min run. All of the straight synthetics show better results than the petroleum hydraulic fluid in this test. Since the load was only 4000 psi, which is well below the film strength of the straight synthetics, good wear characteristics could be expected at considerably higher loadings. This would not be true with a fluid possessing relatively low film strength, as the film of lubricant would fail and scoring and seizure would occur. Because the amount of lubrication required by pumps or other components varies, this information should be used only as a guide to screen candidate fluids. If there is any question, the pump, or other system component manufacturer, should be contacted for specific information.

VISCOSITY. The ideal fluid should have the optimum viscosity for whatever temperature is best for operations of the systems. It should, in addition, undergo small changes of viscosity with changes in temperature. Most pump manufacturers have definite recommendations for the fluid viscosity with which their pump will operate best. Usually, this specification is the controlling factor, and other components in the hydraulic system are designed to operate at or near this value.

The viscosities of the various straight synthetic fluids are charted in Fig. 3. The majority of hydraulic pumps require a fluid of between 150 and 300 SSU at 100 F. Tricresyl phosphate, Aroclor 1248 (the most commonly used grade of Aroclor) and Pydraul F-9 all fall well within this range. They differ in the way they vary above and below 100 F., this being a measure of viscosity index. Aroclor has a very low viscosity index and thus thickens more rapidly at low temperatures and thins out more rapidly at higher temperatures. Tricresyl phosphate has a viscosity index of around −40, which is somewhat better than that of Aroclor 1248. Pydraul F-9's viscosity index is around +30, showing the least change of viscosity with temperature. Consideration should therefore be given in the design of the system to the temperatures which will be encountered and the pump which will be used. Both maximum and minimum temperatures should be estimated as these will have a considerable importance in selecting the best and the most economical fluid for the application.

Table III—Almen Wear Test

Fluid	Wear (mg metal lost)
Tricresyl Phosphate	1.5
Aroclor 1248	39.0
Pydraul F-9	2.0
Typical petroleum oil	Seized in 1 min

STABILITY AND VOLATILITY. The ideal fluid should be mechanically and chemically stable, and not susceptible to hydrolysis or evaporation. In most installations the hydraulic fluid is exposed to moisture, air and heat. The three synthetics have excellent stability and are very resistant to oxidation, as might be expected of fire-resistant materials. All three can be used continuously to a temperature as high as 300 F. Aroclor can be used to approximately 600 F.

The corrosion and oxidation test for which results are

Table IV—Corrosion and Oxidation Test (AN-VV-0-366b)

	Pydraul F-9		
	Initial	Final	Allowable
Viscosity (Cs at 130F)	23.6	24.1 (+2.1 percent)	−5 to +20 percent
Neutralization No.	0.05	0.07	+0.20
Fluid evaporation		3.0 percent	8 percent
Fluid separation		None	None
Effect on Metals (mg/sq. cm)			
Copper		−0.16	±0.6
Iron		+0.01	±0.2
Aluminum		+0.02	±0.2
Magnesium		+0.02	±0.2

Table V—Hydrolytic Stability (MIL-F-7100)

	Pydraul F-9		
	Initial	Final	Allowable
Viscosity (Cs at 130 F.)	20.91	20.13 (−3.7 percent)	−5 to +15 percent
Acidity (NN)			
Fluid Layer	0.08	0.08	
Water Layer		0.03	0.63 total
Effect on Copper (mg./sq cm)		−0.05	±0.5
Sludge (g)		0.002	0.375

Table VI—Bulk Modulus

Aroclor 1248	428,000 psi
Pydraul F-9	387,000 psi
Distilled water	337,000 psi
Typical petroleum fluid	280,000 psi

shown in Table IV consists of strips of copper, iron and magnesium immersed together in the fluid. The fluid is then heated to 210 F and held at that temperature for 168 hrs, after which time the strips and fluid are examined. The hydrolytic stability test, the results for which are shown in Table V, consists of placing a mixture of the fluid and water in a bottle along with a strip of pure copper to promote hydrolysis. The bottle is capped and rotated end-over-end for 48 hr at 200 F after which the liquids are then checked. Results of both of the tests show the straight synthetics to be very stable, the actual changes being considerably less than allowed under the specification. While the tests are for only one fluid, the other two types probably exhibit similar results.

From the field data available it appears that within the temperature limitations mentioned, the synthetic fire-resistant hydraulic fluids are remarkably long-lived. Leakage and line breaks seem to be the only cause of loss of fluid. Because they do not mix with water, reclaiming spilled or contaminated synthetic fluids is simply a matter of settling and filtering.

COMPRESSIBILITY. In some hydraulic applications compressibility is of great importance. For example, in machine tools or in control systems the fluid should be as "rigid" as possible. This is less important in die casting, but still response and efficiency of the system are better with less compressible fluids.

In Table VI, compressibility is shown as bulk modulus. The bulk modulus is the reciprocal of the compressibility, and the higher the number the less compressible the fluid.

TOXICITY AND ODOR. Any fluid used industrially should have low toxicity and present no industrial hazards. All three of the synthetics have been manufactured and used for many years. Considerable toxicological work has been done and complete data are now available.

In the vapor state, after exposure to hot surfaces, tricresyl phosphate and Pydraul F-9 have gross, acute toxicities comparable to that of petroleum oil under the same conditions. Aroclor, when used at higher temperatures, as in heat exchangers, should be provided with adequate ventilation if it is an open system. When used in the normal closed hydraulic system no special precautions are necessary. All of the fluids have distinctive though not objectionable odors. Because it is somewhat different than that of petroleum fluids, the odor serves a useful purpose in calling attention to a leak.

Design Considerations

PACKINGS AND SEALS. The choice of packings and seals was the greatest single problem that faced initial application of the straight synthetic fluids. All three caused swelling of neoprene, probably the most commonly used packing material. This did not present a problem in static seals, since a tighter joint was usually obtained, although it was necessary to replace the packing if it was removed. But in dynamic or moving seals the swelling could not be tolerated.

Investigations have now shown that a number of elastomers can be used with these fluids without swelling, such as butyl rubber, Teflon, Kel-F, nylon, polyethylene, silicone, leather and vegetable fibers. Practically all packing manufacturers now supply packings in all configurations which may be used with the synthetic fluids.

A similar situation with regard to paint, many types of which were stripped by synthetics, has been resolved by several manufacturers who now offer finishes not affected by tricresyl phosphate, Aroclor or Pydraul F-9.

CONVERSION AND PRICE. Conversion of existing equipment to one of the synthetic fluids is relatively simple and the manufacturers supply detailed information. Generally all that is necessary is that the system be drained and cleaned as thoroughly as practical before charging.

Obviously, there is more to the cost story than a cost-per-gallon comparison. There is, in addition to such incalculable factors as employe morale and greater safety, the benefit of reduced downtime and loss of production. Nevertheless, fluid losses must be reduced as far as possible. Here the designer can help by paying particular attention to methods of conserving fluid when he specifies a synthetic fire-resistant hydraulic fluid. The high stability of the fluids and the fact that they can be reclaimed also can contribute appreciable savings.

Table I—Compositions of Nickel Plating Solutions

A. Zinc Immersion Solution

(1) Alkaline Cleaning
Oakite #90: 4 oz/gal
5 sec at 190 F
(2) Acid Pickle
Chromic acid: 4.7 oz/gal
Sulfuric acid: 24 oz/gal
5 min at 180 F
(3) Mixed Acid Dip
3 parts nitric acid (conc)
1 part hydrofluoric acid (48%)
5 sec at room temp
(4) Nitric Acid
2 parts nitric acid (conc)
1 part water
10 sec at room temp
(5) Zinc Immersion Treatment (24ST)
Zinc sulfate: 47.5 oz/gal
Sod hydroxide (76%) 70.4 oz/gal
10 min at room temp

Specimens water rinsed after each operation. Following zinc immersion, specimens water rinsed and then spray rinsed. (See Ref #5 for modified procedure)

B. Phosphoric Acid Solution

(1) Alkaline Cleaning
Oakite #90: 4 oz/gal
5 sec at 190 F
(2) Anodizing Electrolyte for 3SH14
Phosphoric acid: 43.7 oz/gal
10 min at 90 F; cur dens: 12 amp/sq ft
(3) Anodizing Electrolyte for Alclad 24S-O
Phosphoric acid: 67 oz/gal
10 min at 90 F; cur dens: 12 amp/sq ft

Specimens water rinsed following each of the several operations.

C. Rochelle Copper Plating Solution

Copper Cyanide: 5.5 oz/gal
Total sodium cyanide: 6.5 oz/gal
Sodium carbonate: 4.0 oz/gal
Rochelle salts: 8.0 oz/gal
Free sodium cyanide: 0.50 oz/gal
pH: 10.0; temp: 100 F; cur dens: 20 amp/sq ft

Zinc immersion treated specimens first copper plated at 30 amp/sq ft for 30 sec. Current density was then reduced to 20 amp/sq ft. Total plating time: 10 min.

D. Chloride-Sulfate Nickel Solution

Nickel sulfate: 26 oz/gal
Nickel chloride: 23 oz/gal
Boric acid: 5.3 oz/gal
pH: 2.0; temp: 115 F; cur dens: 75 amp/sq ft.

Nickel Plated Aluminum Sheet

Tests on 3S and Alclad 24S-T4 aluminum alloy specimens given phosphoric acid anodic treatment and then chloride-sulfate nickel plated show that—

- **yield strength increases with plating thickness**
- **endurance strength is not affected**
- **corrosion resistance varies with environment**
- **standard forming and heat-treating procedures can be followed very closely**

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THE DEVELOPMENT of processes for depositing adherent, ductile and corrosion resisting nickel deposits on aluminum sheet, which can be heat treated and formed after plating, has suggested applications where erosion and abrasion are important factors and also where aluminum's light weight and nickel's corrosion resistance are desirable. Thus, a test program was conducted to determine the answers to some of the more practical problems which might confront the users of plated aluminum. Two grades of aluminum were selected for testing: Alclad 24S for its high strength properties and 3S because of its adaptability to forming.

The results of plating and mechanical tests indicate the properties of nickel plated aluminum alloys will permit its heat treatment and fabrication with but little deviation from standard procedures. With the exception of applications involving extended exposure to salt atmospheres, corrosion-free service apparently can be obtained by proper selection of aluminum alloy and plating thickness. Where nickel plated aluminum is required in a finished product, it appears feasible when design limitations permit, to plate aluminum sheet before rather than after all forming, bending and heat treatment operations. This insures coatings of uniform thickness over all surfaces, regardless of the shape or complexity of the finished item. The advantages to be gained from this feature alone are many.

* *The data presented in this article are those of the authors and are not to be construed as official data released by the Department of the Navy.*

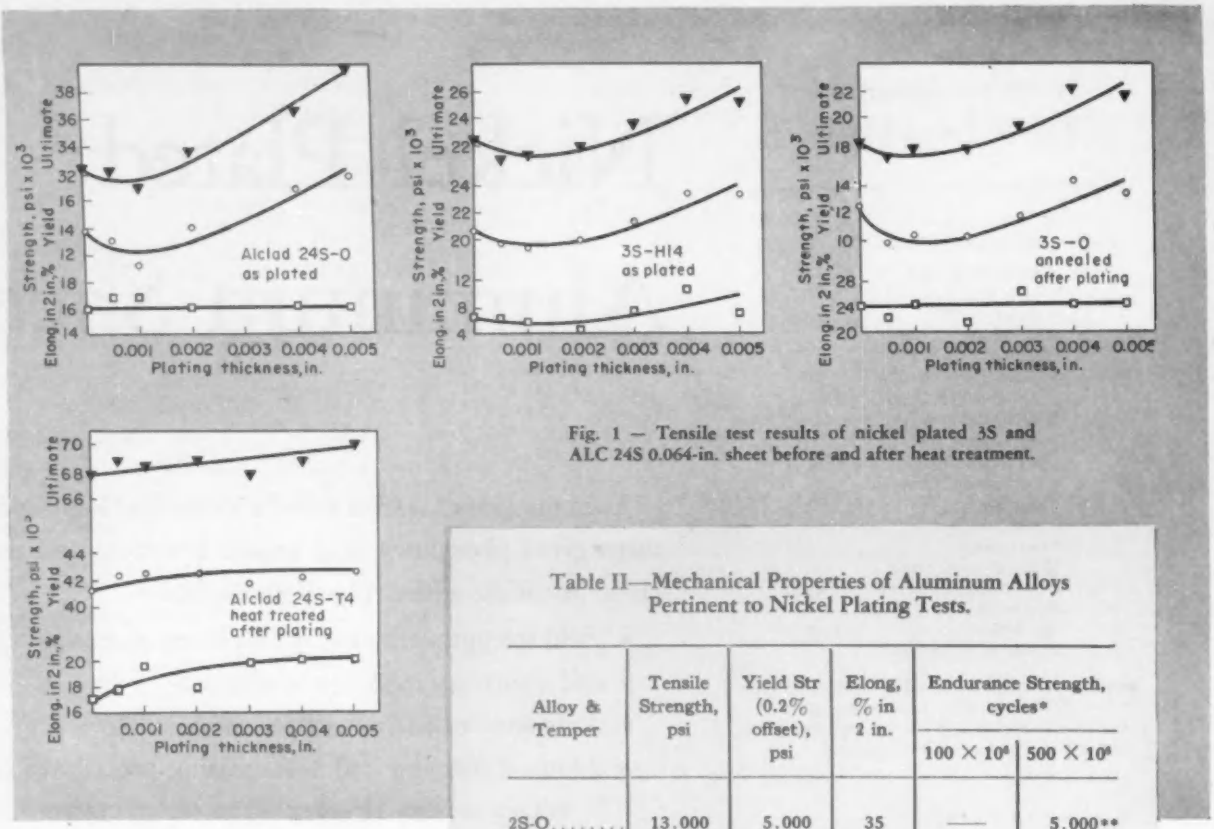

Fig. 1 — Tensile test results of nickel plated 3S and ALC 24S 0.064-in. sheet before and after heat treatment.

Table II—Mechanical Properties of Aluminum Alloys Pertinent to Nickel Plating Tests.

Alloy & Temper	Tensile Strength, psi	Yield Str (0.2% offset), psi	Elong, % in 2 in.	Endurance Strength, cycles*	
				100 × 10⁶	500 × 10⁶
2S-O	13,000	5,000	35	—	5,000**
3S-O	16,000	6,000	30	—	—
3S-H14	21,500	19,000	8	—	—
24S-O	27,000	11,000	19	—	—
24S-T3	70,000	50,000	18	18,000	18,000
24S-T4	68,000	48,000	20	20,000**	18,000**
AlC 24S-T3	64,000	44,000	18	13,000	13,000
AlC 24S-T4	64,000	42,000	19	13,000***	—

* Values are for 0.064-in. sheet as listed in ANC-5 Bulletin "Strength of Metal Aircraft Elements," unless otherwise noted.
** From tests of 0.3 in. round specimens.
*** From tests of 0.064-in. sheet.

Pretreatment Processes

Of the several procedures[1, 2] available for plating on aluminum, there are two in wide usage. One is the zinc immersion process which produces a thin adherent, intermediate deposit of zinc on aluminum, and the other involves plating over an oxide coating formed by electrolysis in phosphoric acid solution. Of the two, the zinc immersion process requires less equipment, is easier to control and is less critical with respect to alloy composition. However, early work in the test program indicated that, while a thin electro deposit of copper followed by nickel could be plated over the zinc immersion coatings, heat treatment of the aluminum alloys usually resulted in separation of the plating from the aluminum.

By contrast, the phosphoric acid anodic process eliminated this difficulty. In this case, where adhesion of the plating is obtained through mechanical keying with the porous anodic coating, there was no adverse effect from heat treatment and quenching of the aluminum alloys. The phosphoric acid pretreatment was therefore utilized prior to nickel plating the remainder of the test specimens. The zinc immersion and phosphoric acid anodic processes are outlined in Table I (A) and (B), along with a description of the Rochelle copper plating procedure (C) which followed the zinc immersion phase.

The phosphoric acid process is somewhat critical with respect to alloy composition. While consistently good results were obtained with 2S and 3S alloys, poor adhesion of the plating to 24S alloy occurred frequently. Further tests indicated that Alclad 24S alloy was satisfactory in this respect.

Nickel Plating

Although the relative protection conferred by nickel coatings of equal thickness is similar, the physical and mechanical properties of these coatings deposited from nickel plating solutions of various chemical compositions may differ significantly.[3, 4] In consideration of such factors as ductility, plating speed, current efficiency, ease of control and relative freedom from pitting, the chloride-sulfate[5] nickel bath was selected as most suitable for this work, even though other solutions such as the Watts and all-chloride baths produce equally sat-

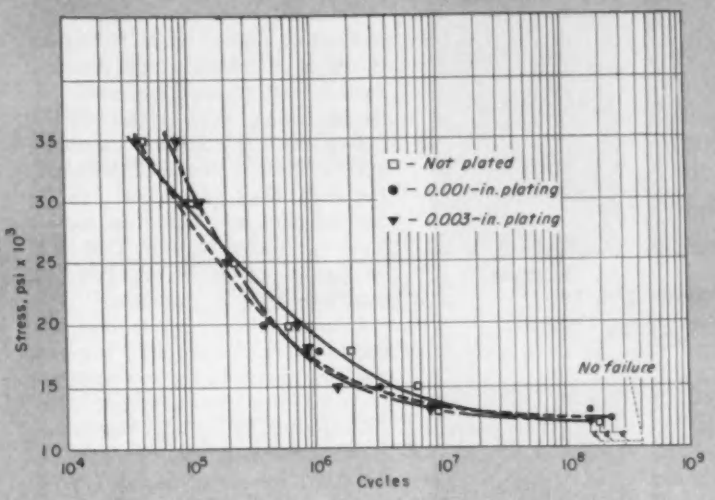

Fig. 2—Effect of nickel plating on the endurance strength of ALC 24S-T4 0.064-in. sheet. Specimens were plated before heat treatment and stresses calculated for base metal thickness.

Table III—Summary of Olsen Cup Ductility Test Results

Alloy & Temper	Plating Thickness, in.	Deflection at Rupture of Aluminum, in.*		Deflection at Rupture of Plating, in.*	
		Against Plating	Side Opp Plating	Against Plating	Side Opp Plating
3S-O.....	——	0.406	——	——	——
3S-O.....	0.001	0.394	0.401	0.255	0.157
3S-O.....	0.003	0.378	0.401	0.290	0.220
AlC 24S-T4..	——	0.207	——	——	——
AlC 24S-T4..	0.001	0.199	0.212	0.199	0.212
AlC 24S-T4..	0.003	0.203	0.217	0.203	0.217

* Above values are average of five measurements.

isfactory nickel deposits. The solution composition and operating conditions of the chloride-sulfate bath are given in Table I(D).

Prior to plating test specimens, the quality of the deposit was checked by plating stainless steel cathodes which had been solvent cleaned. These cathodes were plated at 50 amp per sq ft for 30 min and the deposit inspected for indications of cracking and peeling. The edges of the stainless steel cathodes were filed and the loosely-adherent plating detached. Ductility of the deposits was then checked qualitatively by bend tests according to a predetermined procedure.

Preparation of Test Specimens

Test specimens were prepared from 0.004 in. sheet and nickel plated on one side to thicknesses from 0.001 to 0.005 in. Table II lists the mechanical properties of the pertinent alloys.

Experimentation during the initial tests indicated that thorough cleaning and frequent inspection at each step were essential if consistent results were to be obtained. Following alkaline cleaning, the specimens were inspected for water breaks and supplementary cleaning, if required, was accomplished by light scrubbing with pumice followed by recleaning in alkaline solution according to standard practice.

An effective means for evaluating the condition of the surface following anodizing was afforded by small adherent bubbles that sometimes appeared on the surface. Their presence indicated inadequate cleaning which would result in poor adhesion of the nickel coating.

Best results were obtained by applying the plating potential prior to entry of the specimens into the agitated solution. Two groups of specimens were nickel plated one of which was subsequently heat treated. The 3S specimens in the latter group were heated at 800 F for one hour and air cooled; while the Alclad 24S specimens were solution heat treated at 920 F and cold water quenched.

Mechanical Properties

Machined specimens were tested mechanically for ultimate tensile, yield strength and percentage elongation. Curves based on the original thickness of the 3S and Alclad 24S sheet in the as-plated and the plated-and-heat-treated conditions are shown in Fig. 1 for the various plating thicknesses. The values for Alclad 24S-O, 3S-H14 and 3S-O show that the ultimate and yield strengths are reduced when the plating is thin but increase with increasing plating thickness.

Fatigue tests were conducted on Krouse sheet flexure fatigue machines operated at 1,500 reversals of stress about the zero axis per minute. The endurance strength was determined for 100 x 10^6 cycles of reverse stress and, as can be noted in Table II, the endurance strength of 24S-T3 and –T4 is lowered substantially by the presence of cladding. Presumably this occurs because of the significantly lower values for the cladding as compared to those for the case. Assuming that incipient failure occurs originally in the outer fibers which are most highly stressed, cracks propagate through the cladding and then into the core where final failure occurs.

Normally, nickel coatings deposited from solutions containing no addition agents exhibit residual tensile stresses which result in a marked reduction of endurance values for plated metals such as aluminum and steel. The nickel plating was therefore expected to cause a further reduction in endurance strength. On the contrary, the S-N curves plotted in Fig. 2 for Al-

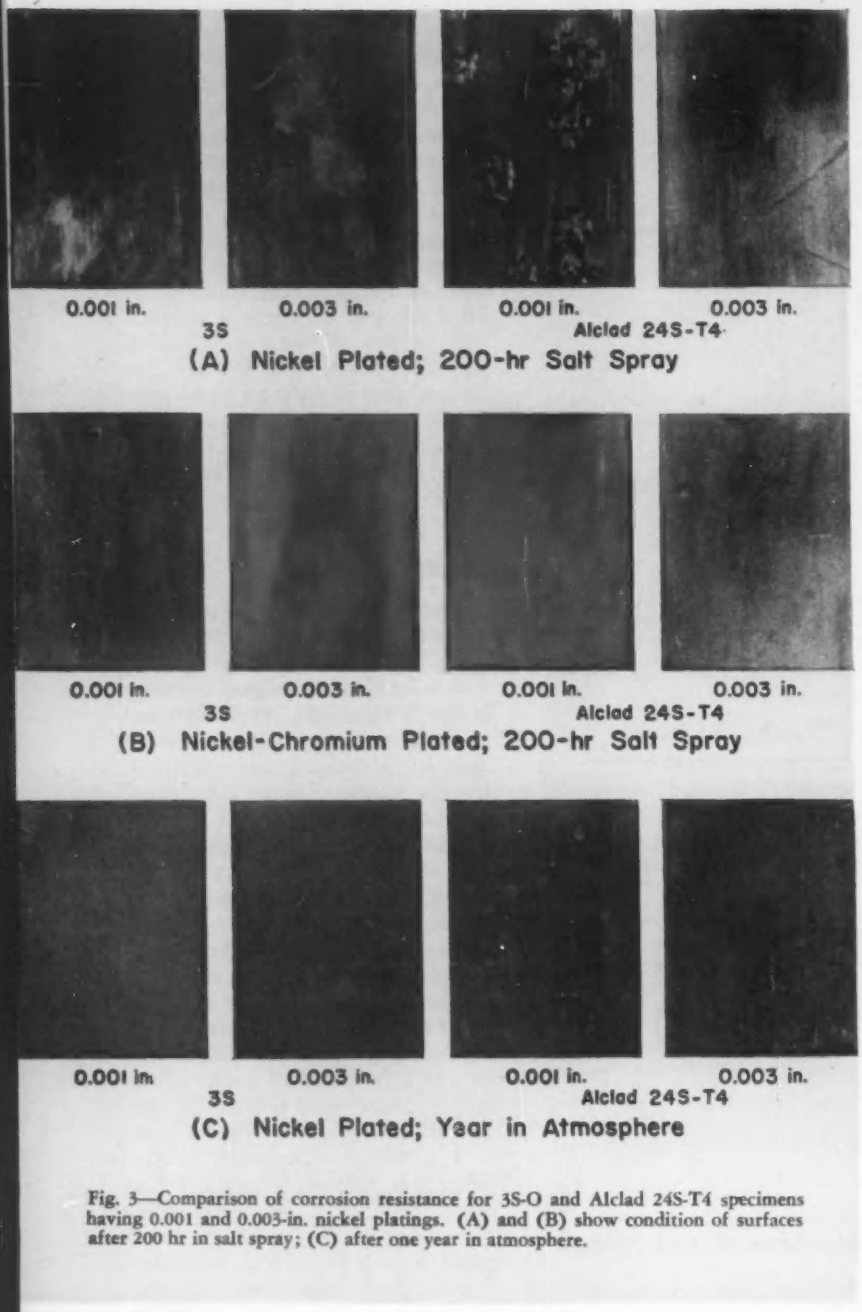

Fig. 3—Comparison of corrosion resistance for 3S-O and Alclad 24S-T4 specimens having 0.001 and 0.003-in. nickel platings. (A) and (B) show condition of surfaces after 200 hr in salt spray; (C) after one year in atmosphere.

clad 24S-T4, indicate that, substantially, nickel plating has no adverse effect on the endurance strength of the aluminum. Heat treatment after plating apparently stress relieves the nickel, thereby preventing further reduction in endurance strength.

Inasmuch as most applications of these materials involve bending during fabrication, bend tests were conducted on nickel plated 3S-O. Results showed that to prevent cracking of plating on the tension side of a 90 deg bend, the minimum radius is $\frac{1}{16}$ in. Plating thickness has no significant effect.

Ductility of the 3S-O and Alclad 24S-T4 nickel specimens was evaluated on an Olsen tester in which a $\frac{1}{4}$ in. ball plunger was forced against one side of the specimen until fracture occurred. The depth of the cup formed at the point of fracture was taken as a measure of ductility.

Table III lists these values. With 3S-O sheet, rupture of the plating occurred at a deflection approximately one-half that required for rupture of the aluminum. With Alclad 24S-T4, rupture of the plating and the aluminum occurred at the same deflection. For both 3S-O and Alclad 24S-T4, the deflection was less when applied force was against plating. Deflection for rupture was greater with 0.003 in. than with 0.001 in. coatings.

Standard salt spray tests were conducted at 95 F using a 20 per cent NaCl solution with the specimens positioned 15 deg from the vertical. After exposure for 200 hr, large blisters surrounding corrosion pits developed on the 0.001 in. coated Alclad 24S-T4, whereas with the 3S-O alloy, blistering was much less pronounced. Attack of the 0.003-in. coated specimens was negligible as shown in Fig. 3(A). Application of a 0.0001 in. chromium plate[6] resulted in a significant increase in corrosion protection with the thinner coatings as shown in Fig. 3(B).

Outdoor exposure tests in an industrial atmosphere were conducted at Philadelphia, Pa. Specimens were positioned at an angle of 45 deg, with the plated side uppermost. The results of this test, Fig. 3(C), indicate the general superiority of nickel coatings on 3S-O as compared to Alclad 24S-T4. The 0.001-in. coated Alclad 24S-T4 exhibited numerous corrosion pits, whereas the appearance of the 0.001 in. coated 3S-O and the 0.003 in. coated Alclad 24S-T4 is comparable and little corrosion is present.

Although these exposure data indicate that satisfactory service can be expected under certain conditions, environmental testing should precede any contemplated use of nickel coatings on aluminum.

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Effects of Shock Loadings

Contrary to popular conception, a shock load is not always twice as severe as a static load of the same numerical magnitude. In fact, whether or not there will be any dynamic effects—as well as the magnitude of these effects—will be determined by the ratio of time rate of application and duration of the load to the natural period of the structure. For large values of this ratio, the effect of a shock load may be equivalent to that of a static load.

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A LOAD SUDDENLY APPLIED to an elastic structure is generally considered to be twice as severe as the same load applied statically. The reasoning behind this theory is simple and direct, but it assumes that the load can be applied instantaneously, which may or may not be closely approximated in practice.

With elastic structures, analytical studies reveal that for a single degree of freedom, the intervals of time during which the load is applied, maintained, and removed, should be measured in terms of the natural period of free vibration. In addition, the manner in which the load builds up, or is removed, in relation to time has an important influence on the peak stress set up under dynamic conditions.

Thus a dynamic load factor, D, is introduced which can be defined as follows:

$$D = \frac{\text{Maximum Stress with Dynamic Load}}{\text{Maximum Stress with Static Load}}$$

For dynamic loads that are maintained constant for an appreciable time relative to the natural period, the theoretical values of D are:

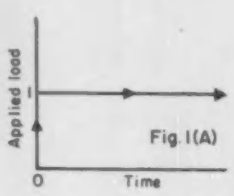
Manner of Loading	*Dynamic Load Factor, D* (Theoretical Value)
Instantaneous application	2
Sustained application	1

In practice, the influence of a rapidly applied load, which remains applied for some time relative to the natural period, can be expected to be between one and two times as great as the effect of a static load of equal magnitude. Also, if the time of loading is exactly an integral multiple of the natural period, there is no oscillation and no build-up in excess of the static load. For times of load application greater than four times the natural period, T, the dynamic load factor is less than 1.07. Figs. 1 and 2 show the effects of instantaneously and uniformly applied loads, respectively, when maintained indefinitely. The latter also relates the time of load application to the natural period. The relationship between the dynamic load factor and the ratio of time of load application to natural period is shown in Fig. 3 for the uniformly applied load. It is seen that D is less than 1.5 for durations of load application greater than 5/8 T.

This example does not take into account the time during which the load is maintained. However, since one of the fundamental elements in impact loading is the duration of the shock, the time under load must be considered. Fig. 4(A) illustrates the effect of a square wave pulse in which the load is applied instantaneously, remains constant for a time, t_1, and then is removed instantaneously.

If the duration of load, t_1, is long in comparison with the natural period, the result is the same as that initially cited and the dynamic load factor is two. Fig. 4(B) shows what happens as the duration of load is reduced. For t_1 less than $T/2$, the dynamic load factor drops below two, reaches unity when $t_1 = 1/6\ T$ and finally is zero for $t_1 = 0$. It is noteworthy that for very short durations relative to the natural period, the stresses produced by dynamic loading will be less than those produced by an equal static load.

In Fig. 5 a triangular pulse is shown



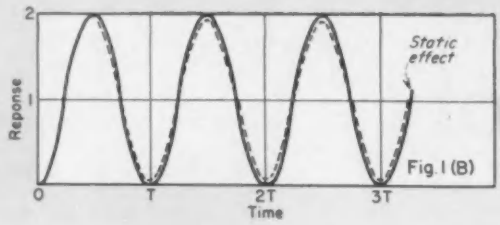
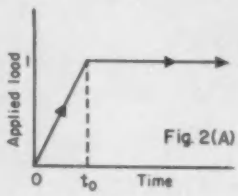


Fig. 1—Instantaneously applied load. Force-time relationship in (A) indicates that the load is applied in zero time and maintained constant. The result is an oscillation as shown in (B). The time interval, T, on the abcissa corresponds to the period of free vibration and the unit, 1, on the ordinate, to the equivalent static effect. The oscillation reaches a maximum value that is twice as great as the mean or static effect. The ratio of the maximum to the mean represents the dynamic load factor. The dotted line indicates the influence of damping which at first has negligible effect, but ultimately will eliminate the oscillation and leave the equivalent of a static load.



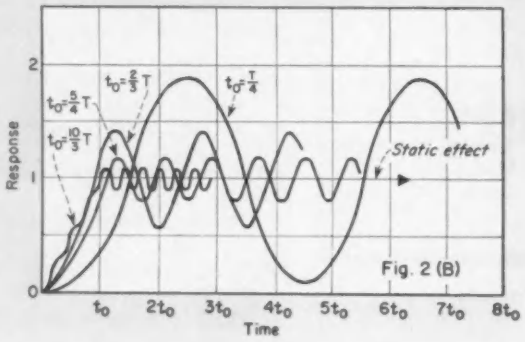


Fig. 2—Load applied uniformly to its maximum and then maintained constant is shown in (A). Curves in (B) give the corresponding response for various times of load application in terms of the natural period. For durations of load application less than about $\frac{1}{4}$ of the natural period, D is between 1.8 and 2, and as the time of loading is increased the response deviates less and less from the mean with the result that D approaches unity.

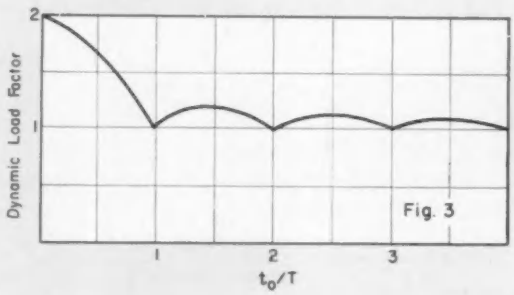


Fig. 3—Dynamic load factor for uniformly applied load—of Fig. 2(A). Note that D is less than 1.5 for all load durations greater than about $\frac{1}{4}$ T.

with total duration of time t_1. In this instance, the maximum value of the dynamic load factor does not exceed 1.52, which occurs for a pulse time slightly less than the natural period. For pulse durations with periods longer than five times the natural period, the effect of a dynamic load will not exceed that of an equivalent static load by more than 11 percent.

The foregoing points out the possibility of maintaining some control over the dynamic load factor by changing the duration of load, its manner of application or the natural period of the load-carrying member. Force-time relationships more complicated than those indicated—for example, the force-time relationship of a gun blast or similar explosion—can be approximated by superposition.

To provide accurate data on the effects of shock loading on Meehanite metal a test program using the loading diagram of Fig. 6 was undertaken. Type "GA" Meehanite was chosen for these tests and test bars 1 x 2½ x 42 were machined from castings, all longitudinal surfaces being finished by surface grinding. For the two specimens, Nos. 1 and 2, loading was applied as indicated in Fig. 2(A). This was done with a pneumatically operated testing machine capable of building up the load in a thousandth of a second (t = 0.001 sec) and then maintaining it constant for any desired length of time.

Observations of strain were made at load levels 1,000 lb apart, to a maximum of 8,000 lb which was the safe limit for the testing machine. Because of the method of operating the machine, it was necessary to remove the load after each loading. However, in every instance, the load was maintained constant for a long time relative to the natural period of vibration prior to its removal.

Since the natural period, T, of the test bars was very nearly 0.01 sec, as shown by the oscillogram of Fig. 7, $t_o = T/10$, approximately. This means that theoretically, the dynamic load factor should be between 1.9 and 2.0, as indicated respectively by the curve for $t_o = T/4$ in Fig. 2(B) and Fig. 1 which corresponds to instantaneous loading or $t_o = 0$.

Because the load was applied to the

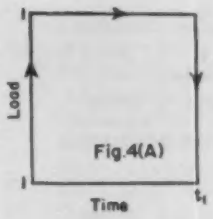
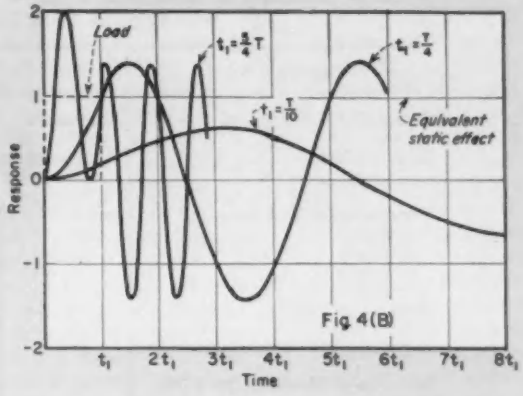
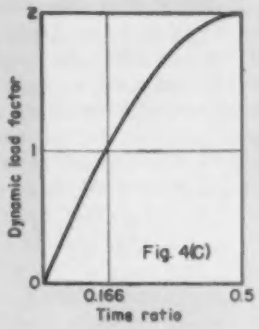
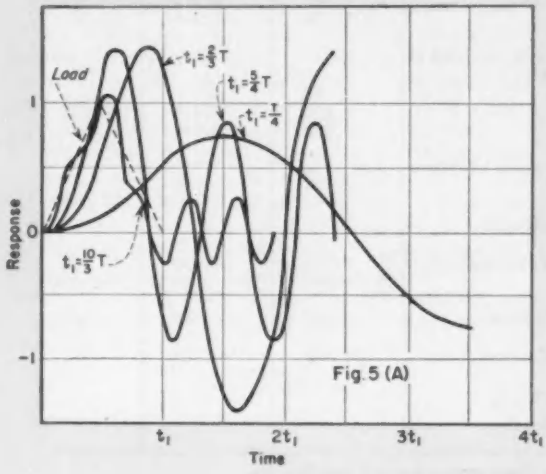


Fig. 4—Dynamic load factor (B) and response curves (C) for a member subjected to a loading cycle represented by the rectangular pulse in (A).







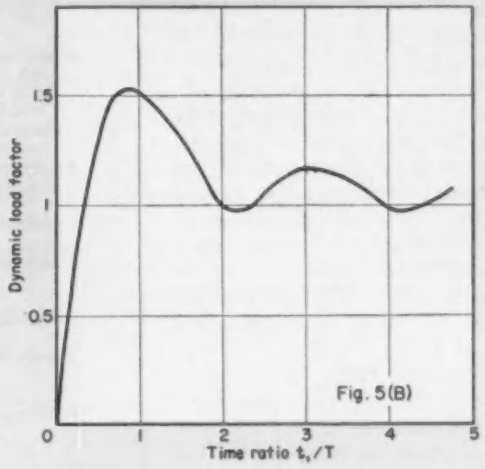


Fig. 5—Response curves and plot of dynamic load factor for a triangular loading pulse.

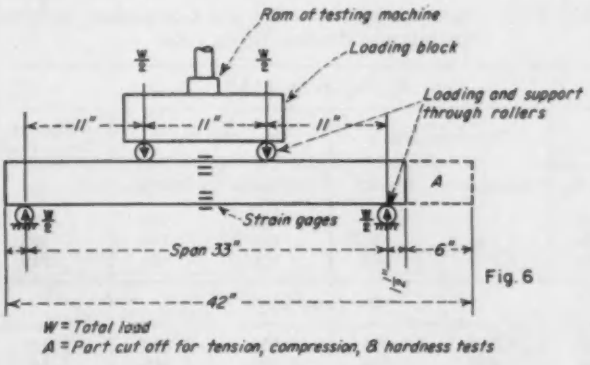


Fig. 6—Loading diagram used to evaluate the effect of shock loading of Meehanite beam specimens. Dotted area (A) represents the section of beam cut off for tension, compression and hardness tests.

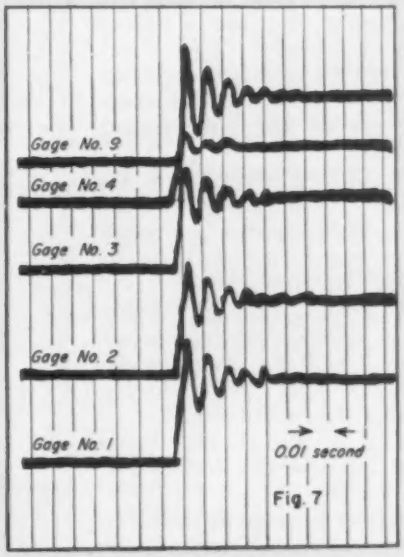


Fig. 7—Typical oscillograms taken for beam specimens.

test specimens through an auxiliary member and rollers it is not unreasonable to expect that the actual or measured values of the dynamic load factor may be little less than the theoretical prediction.

To determine the influence of the dynamic loads on the test bars ten Type A-11, SR-4 strain gages were mounted around the central section of each specimen. The strains produced in the test specimens were measured simultaneously on all gages by means of two six-channel oscillographs which produce records on photographic paper. Fig. 7 is a typical set of oscillograms for five of the strain gages.

The force applied by the testing machine was measured by means of strain gages mounted near the end of the ram, and a check on the observation was provided by measuring the pressure in the cylinder operating the ram. The strain gages on the ram were connected to a cathode ray oscilloscope whose trace was recorded photographically and simultaneously with the indications from the strain gages on the test specimen.

The results of these tests are summarized and compared with static test data in Tables I and II. Although more extensive testing must be done before these results can be generalized, some definite trends are now apparent. The procedure for evaluating the test data is listed in Table III, and the conclusions that have been drawn are:

1. The material appears to behave elastically up to about the same load level whether the load is applied rapidly or gradually.

2. The ratio of dynamic to steady strain up to the elastic limit is approximately the same as the dynamic load factor.

3. Beyond the elastic limit, the maximum strain produced under dynamic loading appears to be nearly twice as great as the strain for the same load applied gradually.

4. Whether a load will produce dynamic effects, (greater influence than static load) and what they are, will depend upon the relationship between the natural period of vibration of the structure and the rate and manner of application and removal of the load.

5. Further investigation should be carried out to substantiate the results obtained thus far.

Table I—Summary of Results of Dynamic Tests and Comparison with Previous Static Test

Specimen No.	No. 1	No. 2	No. 3
Manner of Loading	Dynamic	Dynamic	Static*
Type of Test	All Specimens—Transverse Bending with third point loading		
Dimensions of Test Bars (in.)			
—Length	36	36	36.125
—Depth	2.501	2.503	2.511
—Breadth	1.001	1.001	0.997
Span Length (in.)	33	33	33
Distance of loads from supports (in.)	11	11	11
Modulus of Elasticity (psi x 10^6)	16.7	18.2	18.4
Proportional Limit			
Load on Beam (lb)	4,000	3,500	3,900
Stress (psi)	21,100	18,500	20,600
Strain on tension side at 8,000 lb load, (in./in. x 10^6)			
Total Dynamic	7,750	6,745	
Total Steady	6,120	5,415	3,230
Permanent set	3,400	2,450	
Approximate Frequency of Vibration (cycles/sec)	105	105	.....
Dynamic Load Factor, *D*	1.8	1.7	.....
Maximum Load on specimen (lb)	8,000 (No Rupture)	8,000 (No Rupture)	12,700 (Rupture)
Brinell Hardness Number	215	216	207
Tensile Strength of Material (psi)	53,000	49,300	.....
Ratio $\frac{\text{Proportional Limit}}{\text{Tensile Strength}}$	0.40	0.38	.....

* Data for static test taken from a previous investigation

Table II—Total Strain on Tension Edge and Comparison Between Dynamic and Previous Static Tests

	Strain, in./in. x $10/^6$				
	Specimen No. 1		Specimen No. 2		Previous Static Test
Load, lb	Dynamic	Steady	Dynamic	Steady	
1,000	.....	.....	490	270	285
2,000	1,100	580	980	550	595
3,000	1,770	965	1,490	900	910
Proportional Limit					
4,000	2,250	1,260	2,035	1,245	1,255
5,000	2,930	1,760	2,895	1,915	1,640
6,000	4,070	2,480	3,895	2,745	2,090
7,000	5,610	4,190	4,665	3,505	2,600
8,000	7,750	6,120	6,745	5,415	3,230

Note: 1. Dynamic indicates maximum strain due to shock load. Steady means strain after vibrations had been damped out.
2. Proportional Limits: Specimen No. 1, 4,000 lbs. load; Specimen No. 2 3,500 lbs. load; Previous Static Test 3,900 lbs. load

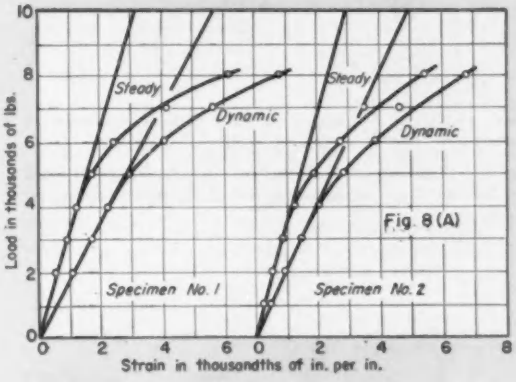
Table III—Procedure for Evaluating Test Data

1. All oscillograms were analyzed to determine the dynamic and steady strains indicated by all strain gages.
2. For each load level on each specimen the distributions of both dynamic and steady strains were plotted across the section and unlikely values were discarded. A modified plot—containing averaged instead of individual observations—is shown in Fig. 9 which shows the distributions of strain at a load of 3,000 lb.
3. To obtain as precise values as possible for the modulus of elasticity, test values were plotted as in Fig. 8 (A).
4. Since the oscillograph records start from a new zero every time an observation is made, they only show the deviation from linear stress-strain relationships for one particular load. This neglects the permanent set established as a result of any previously applied loads.

   To put the load-strain curves on the same basis as those which would be developed from a static test, in which the load is continually increased without returning to zero, the permanent set was determined and added to the oscillograph observations to provide a measure of the total strain developed from the initial condition up to any particular load. For Specimen No. 1 this was accomplished by determining the set indicated by the offsets between the load-strain curve and its initial tangent at each load level.

   After the load of 8,000 lb was reached the total permanent set at each gage location was determined by means of a static strain indicator. This instrument had been used to check the strain gages prior to the dynamic tests so that the differences in observations before and after the high speed loading gave a direct measure of the permanent set. The observation following the 8,000 lb load provided a check on the method used for finding the permanent set on Specimen No. 1 and indicated a discrepancy of about 6 per cent between the two procedures.

   Since the method employed for establishing the permanent set on Specimen No. 1 did not provide a reliable indication of the elastic limit a different procedure was adopted for Specimen No. 2. In the latter, the permanent set was determined by direct observation by taking static strain readings on all gages just before and just after each dynamic loading. This gave better results in spite of slight discrepancies between individual observations and the faired line representing the load-strain relationship.
5. The Dynamic Load Factor was determined from the ratio of the slopes of the initial tangents to the curves representing the dynamic and steady strains. The observed values, 1.8 and 1.7 are slightly below the theoretical value of 2 for an instantaneously applied load.
6. The natural frequency of vibration was determined from the oscillograms which showed that one complete oscillation took place in slightly less than 0.001 second.
7. The plot of the ratio of dynamic to steady strain vs. load, Fig. 8 (B), shows an interesting result for Specimen No. 2. It is suggested that if Specimen No. 1 had been loaded only once for each load then the corresponding values might have been closer to the line drawn through the points for the other specimen. This implies that the steady strains approach the dynamic strains at high loads.



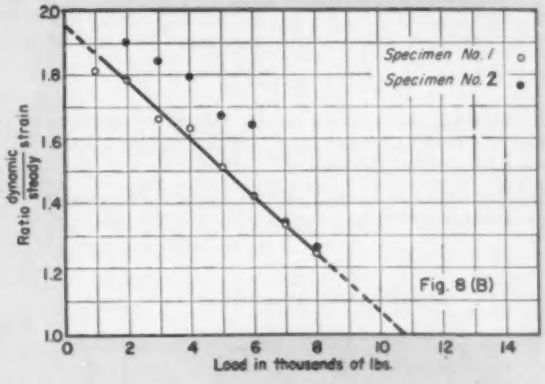


Fig. 8—Load-strain curves (A) for tension edge of specimens Nos. 1 and 3 (B) shows the ratio of dynamic to steady strain plotted against load.

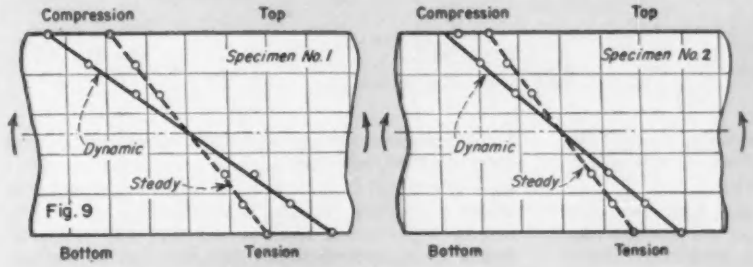


Fig. 9—Averaged plot of strain observations for two specimens at 3,000 lb load.

19 Applications of Helical

Originally devised to reduce thread wear and stripping between steel fasteners and soft materials such as aluminum and magnesium, helical wire inserts are now being used in plastic

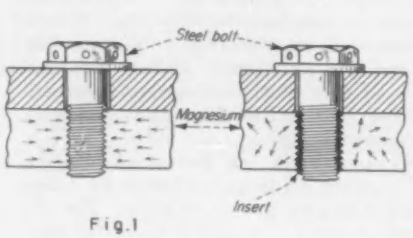


Fig.1

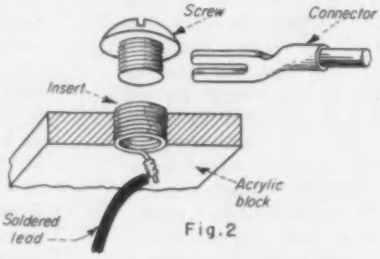


Fig.2

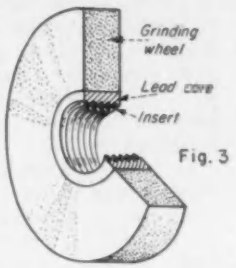


Fig. 3

Fig. 1—Galvanic action between steel bolt and magnesium part, (Left), attacks thread causing part failure. Stainless steel insert, (Right), reduces galvanic action to a negligible amount while strengthening threads.

Fig. 2—Insert used as an electrical connection as well as a thread reinforcement. Unit is threaded into plastic and tang is bent to form soldering lug.

Fig. 3—Direct connection of grinding wheel onto a threaded shaft by using a wire insert. Washers and nut are not required thus simplifying assembly.

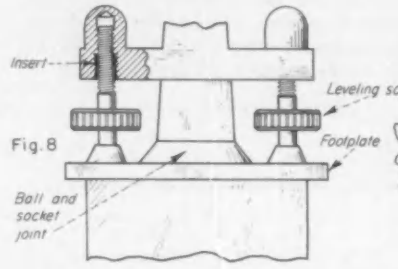


Fig.8

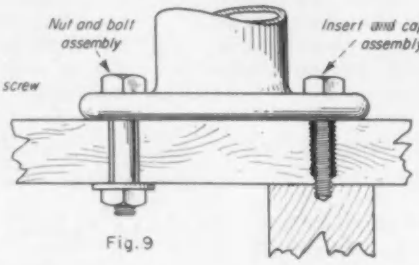


Fig.9

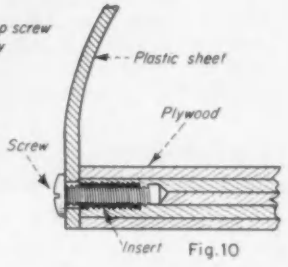


Fig.10

Fig. 8—Wear and backlash can be reduced on adjusting threads. Clamping strength is not needed but intermittent thread travel makes reinforcement desirable.

Fig. 9—Combination of inserts and capscrews permits installation of machinery and other equipment on wood floors and walls. Access to opposite face of the wood is not a factor nor are joists and other obstructions.

Fig. 10—Plastic-to-wood connector. Repeated assembly and disassembly does not affect protected threads in wood or plastic parts.

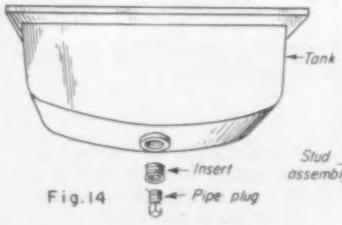
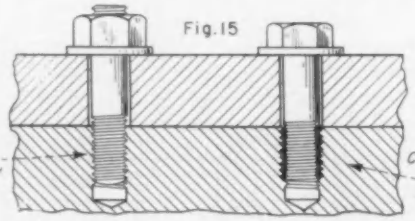


Fig.14



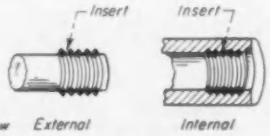


Fig.16

Fig. 14—Seizure and corrosion of pipe threads on compression, fuel and lubricant tanks, pipe lines, fittings, pumps and boilers are prevented by using an insert.

Fig. 15—Stud (Left) transfers thread wear from the tapped hole and into the expendable threads on the stud and nut. Interference fit in the tapped hole is mandatory. Insert (Right) prevents wear and makes stud unnecessary. Lower cost cap screw can be used.

Fig. 16—Thread series can be changed from special to standard, from fine to coarse or vice versa, or corrected in case of a production error by redrilling and retapping. Inserts giving desired thread type can then be inserted.

Wire Inserts

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Heli-Coil Corporation, Danbury, Conn.

and wood for similar purposes. Other applications are to prevent galvanic action, act as electrical connectors, and to reduce weight, cost and number of parts needed in an assembly.

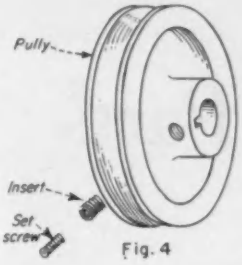

Fig. 4

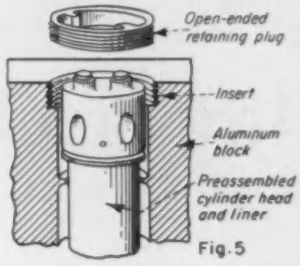

Fig. 5

Fig. 4—Loosening of the set screw by vibration is reduced by using an insert. As pulley is a soft metal die casting set screw tightening often stripped pulley threads.

Fig. 5—Insert withstands combustion thrust of diesel cylinder. It prevents heat seizure and scale on threaded plug making cylinder replacement and servicing easy.

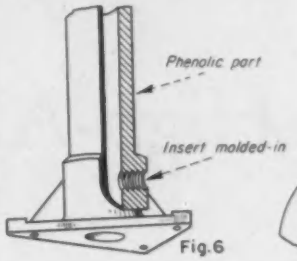

Fig. 6

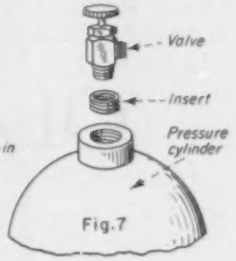

Fig. 7

Fig. 6—Phenolic part insert forms strong thread without tapping and drilling. Insert is resilient, does not crack phenolic or set up local stress concentrations.

Fig. 7—Enlargement of taper pipe threads in necks of pressure vessels, caused by frequent inspection and interchange of fittings, can be reduced by use of wire inserts.

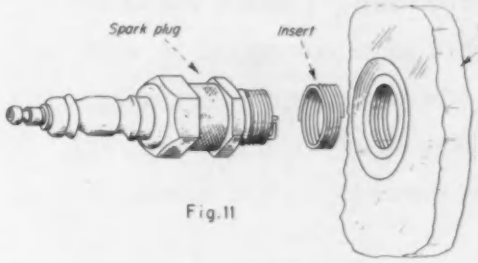

Fig. 11

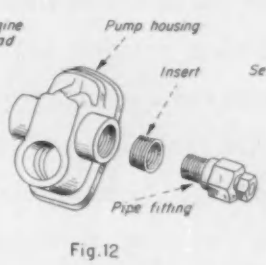

Fig. 12

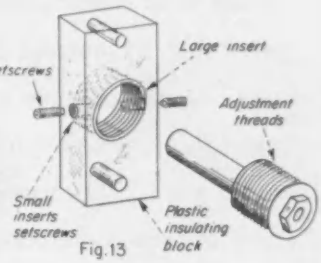

Fig. 13

Fig. 11—Threads are protected from stripping in new aluminum engine heads by inserts. Also can be used to repair stripped spark plug holes in engine heads.

Fig. 12—Insert prevents pipe fittings from peeling chips out of tapped aluminum threads. Introduction of chips into lines could cause malfunctioning of equipment.

Fig. 13—Center insert serves as brakeband to lock adjustable bushing. Small inserts keep set screws from stripping plastic when tightened. Also, adjustment threads can not be marred by end of set screw.

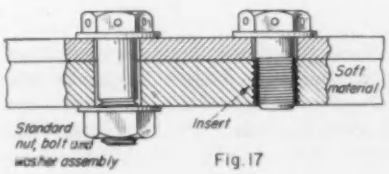

Fig. 17

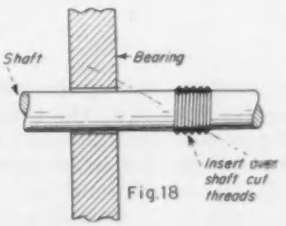

Fig. 18

Fig. 19

Fig. 17—Assembly weight may be reduced. Left view shows the standard method of attaching front and mid frame of a compressor. Lockwire is used after assembly is completed. Right view is new method resulting in weight and space economies.

Fig. 18—Assembly of a shaft through a bearing is simplified by adding external insert over cut shaft threads. Machining the full shaft length is also unnecessary.

Fig. 19—Square tang insert—called screw lock—automatically locks the screw so that lock washers, nuts or wires are unnecessary. Insert locks itself into parent material without need for pins, rings, staking or other devices.

Cast-Weld Construction Of High-Alloy Steel Parts

Casting in carefully chosen sections and then welding often improves the soundness of a complicated casting or simplifies the operation. This is known as cast-weld construction and should be considered when (1) defects cannot be prevented by normal casting practice; (2) when more economical to weld together two or more easily-cast pieces of an otherwise complicated casting; and (3) when this method can make a piece more simply than by any other one construction method. The cast-weld process combines the best features of castings and weldments for many applications.

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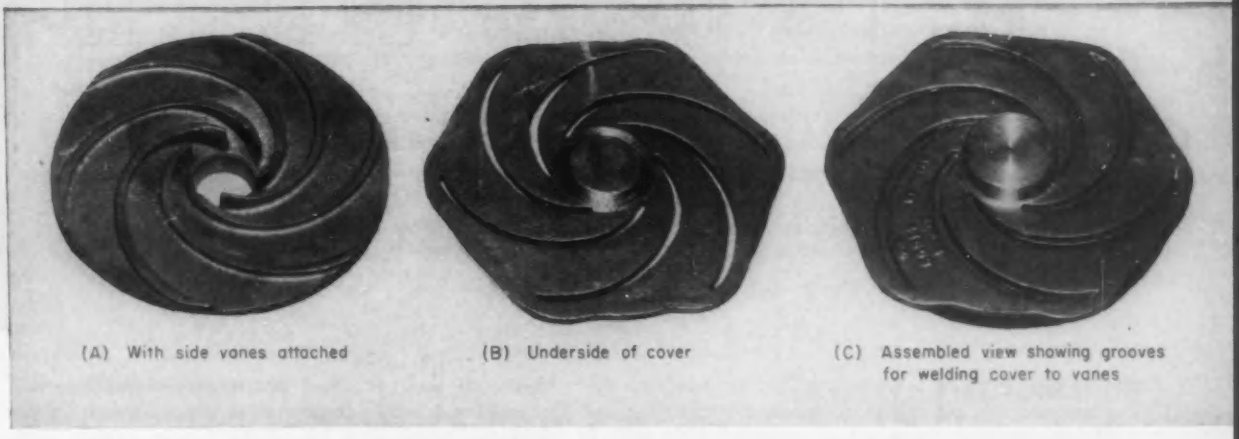
THE MOST SIMPLE AND PRACTICAL METHOD for construction of a metal part is often to cast to shape. However, there are important limitations to the casting of high alloy steel. When the casting of a particular shape results in a high percentage of rejects, the trouble is often in the design. If the design cannot be changed, welding should be considered. There are two possible approaches to the use of welding. Where economically practical, rejects can be repair welded. A more foresighted approach, however, is to design for splitting up of complicated castings into sections that can be cast soundly, after which the sections can be welded together, Figs. 1 and 2. This practice is known as cast-weld construction. Welding has been so closely associated with wrought steel that the welding of castings has often been considered impractical or impossible This is why many wrought products frequently have sections with a multiplicity of welded details. Often a better product would result by casting the complicated sections and joining them to the assembly by welding.

Welding and casting are very closely related. When one examines the nature of welding, it is found to be, in effect, a continuous casting. Metal is melted by an electric arc or gas flame and poured into a metal mold consisting of a beveled joint. The principal difference is that a weld is intentionally fused with the mold, while in a casting the metal solidifies against the mold. The steel-casting industry was probably the biggest single factor in the development of fusion welding, because foundrymen have often been

Fig. 1—Cast-weld construction calling for a flange to be welded on the large ribbed disk. This method saves a large core and eliminates the difficult feeding problem the flange would create.

Fig. 2—Cast-weld construction of a very narrow closed impeller for a centrifugal pump. If cast in one piece, cores would be too thin and fragile with resulting high rejection rates.



(A) With side vanes attached

(B) Underside of cover

(C) Assembled view showing grooves for welding cover to vanes

confronted with a few imperfections in an otherwise perfect casting which had to be weld-repaired.

Welding repair is still an important factor in any steel foundry. In fact, the quality of modern welding is such that defects can be repaired which will pass the most stringent X ray and Zyglo testing requirements. There is thus no need to hesitate in the use of welding for joining castings to one another or to other wrought materials.

WHY WELD?

In casting, one is primarily interested in two things—(1) the size and shape of the part, and (2) the quality of the material. On many complicated castings, the foundry should be consulted; because best results are often obtained by a slight change of the design, which the foundry can recognize but only the designer can authorize. Where the designer and the foundry cannot agree on a change in shape that will produce a sound casting, splitting the member in two pieces for casting and then welding the pieces together will often satisfy both quality and shape requirements.

There are three defects peculiar to castings usually avoidable with good design practice—namely, shrinkage cavities, hot tears, and misruns. When design limitations make such defects unavoidable, specification of cast-weld construction will normally correct the condition. To understand the need for welding, cause of these defects and usual means of avoiding them should be examined.

Table I—Steel Shrinkage by Volume and Length When Cooling to Room Temperature from Typical Casting Conditions

Initial State of Steel	Volumetric Shrinkage Per cent	Linear Shrinkage	
		Per cent	in./ft
Solid—at solidification temp.	7.2	1.9	1/4
Liquid—at solidification temp.	10.2	—	—
300 F above solidification temp.	11.1	—	—

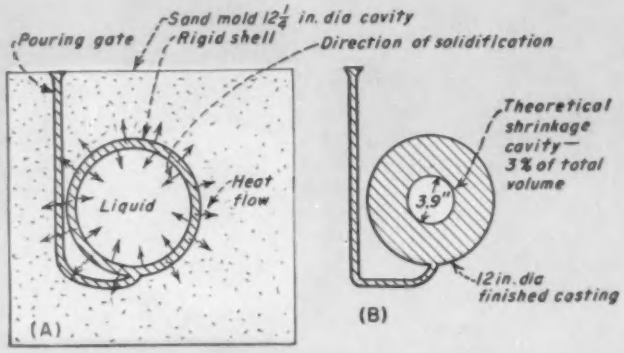


Fig. 3—Example of how a shrinkage cavity is formed in casting of a 12 in. dia steel sphere. (A) A few seconds after pouring. (B) When cooled to room temperature.

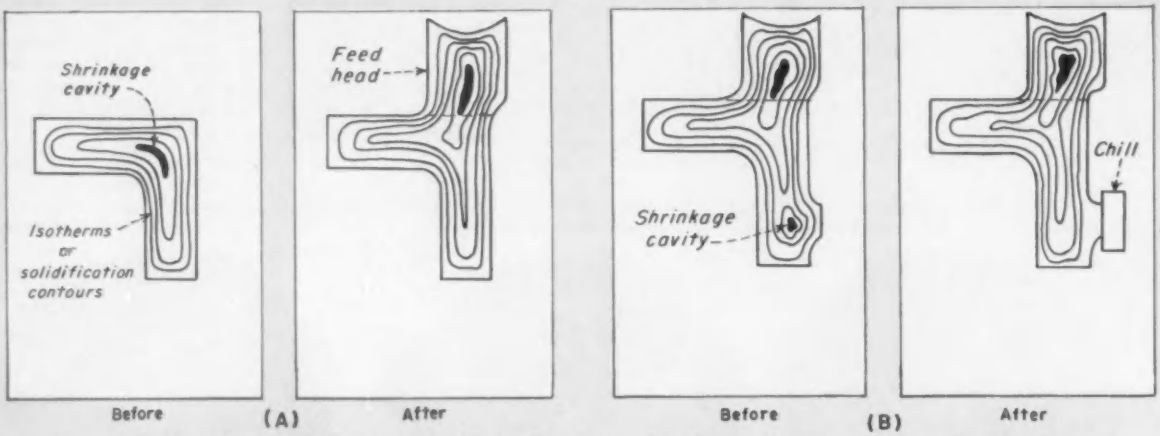


Fig. 4—Elimination of shrinkage cavities by feed heads and chills. When castings are too complicated for these methods to be effective, make casting in sections to provide sufficient space for feed head and chills.

SHRINKAGE CAVITIES

Molten stainless steel must be heated to about 3000 F to obtain proper fluidity for pouring. Most casting problems result from the shrinkage of metal from the pouring temperature to atmospheric. Table I and Fig. 3 illustrate the extent and nature of this shrinkage. When poured into a mold, the metal in direct contact with the mold surfaces solidifies first and forms a rigid shell containing molten metal. Solidification progresses inward from the inside surfaces of this shell at a rate dependent on heat transfer to the mold. The shrinkage of hot molten metal at the center is restrained by the shell, resulting in a void or shrinkage cavity at the last point of solidification of the mass. As it is formed, a partial vacuum exists; thus, atmospheric pressure is important in determining the shape and location of the cavity. When more than one point of final solidification exists, a shrinkage cavity will be formed at each such point. By taking advantage of the fluidity of molten metal, progressive solidification can be employed, which begins at a remote corner of the casting and progresses toward the largest section where a riser or feed head is attached. The riser is a reservoir of molten metal constantly feeding the face of the solidifying mass. It must be of greater volume than the casting to be the last to solidify and thus contain the shrinkage cavity. There are practical problems; for instance, progressive solidification requires a casting shape with tapered section gradually increasing towards the feed head. In most actual castings however, variation in cross-section is not constant; thus a shrinkage cavity results at each change in section, Fig. 4. To avoid this, each isolated molten pocket or hot spot can be fed by an individual riser; but space considerations and economic factors often discourage this practice. Another solution is to incorporate chills in the mold at these points, which increase rate of solidification in the larger sections so that they solidify progressively with the adjacent smaller sections.

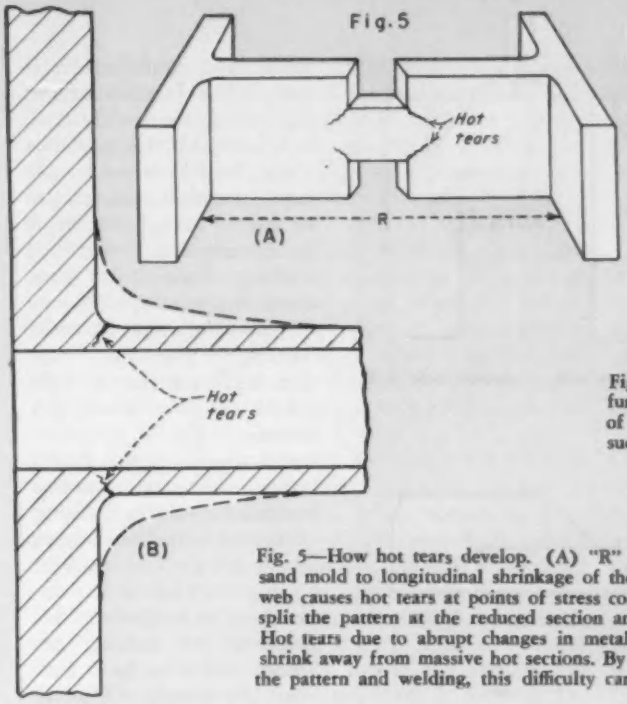


Fig. 5—How hot tears develop. (A) "R" represents the resistance offered by the sand mold to longitudinal shrinkage of the web section. Resultant tension in the web causes hot tears at points of stress concentration. To prevent this happening, split the pattern at the reduced section and weld the two castings together. (B) Hot tears due to abrupt changes in metal section. Thin sections cool faster and shrink away from massive hot sections. By tapering the thin section or by splitting the pattern and welding, this difficulty can be avoided.

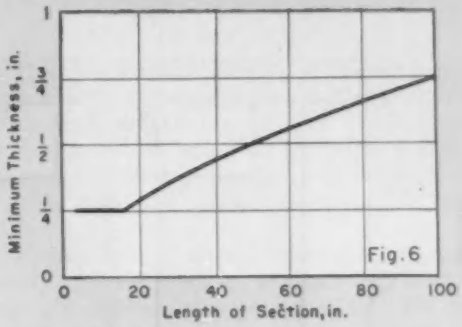


Fig. 6—Minimum thickness of a cast steel section as a function of its largest dimension. When thin sections of large areas are required, use a wrought plate for such parts and weld to the cast parts.

HISTORY. Cast-weld construction is a natural development from experience with weld repair. Before 1900 weld repair of castings involved drilling through the defect and out on the other side of the casting; the molding of a pouring gate around the top of the hole; the pouring of hot metal which was allowed to run through until the cavity reached fusion temperature; the plugging of the hole at the bottom; the cessation of pouring; and the solidification of the molten mass.

The first arc and gas welding for casting repair began soon after the turn of the century, but the quality of this early welding would never meet present-day standards. Not until the late twenties were coated electrodes common; and until their advent, gas welding was used extensively for casting repair. Gas welding produced a better quality weld than bare-wire arc welding but was never very satisfactory for welding stainless because of the refractory nature of the chromium oxides. The alloy-casting industry is now finding use for latest fusion-welding processes—inert-gas shielded arc welding. Although the tungsten-arc process is used principally for repair, the consumable electrode method is most useful for automatic welding in cast-weld construction.

These chills usually consist of pieces of metal or a more highly conductive molding material. On many complicated castings there is insufficient space in the mold for all required feed heads and chills; thus, if no change in the design is possible, splitting of the casting into two or more parts and welding is a necessity.

HOT TEARS

Hot tear defects also result from the contraction of hot metal; but unlike shrinkage cavities, they show up as cracks or ruptures of the solidified metal. Thermal stresses, which result from restraint against contraction due to cooling, and lack of ductility at high temperature, are the direct causes. This restraint may be from the mold or from wide difference in size and thickness of different parts of the casting, and are illustrated in Fig. 5. The lack of ductility of certain alloy steels at high temperature is known as hot-shortness, and castings made of hot-short alloys are very susceptible to hot tearing. Design correction is to split the casting in two at the normal point of rupture with subsequent welding together of the two parts.

MISRUNS

A misrun is the result when the hot metal fails to completely fill the mold cavity. Misruns result from failure to follow the rules of good casting design. Steels, particularly stainless, are sluggish with resultant difficulty in filling long, thin mold sections. The minimum thickness of sections for a steel sand casting is ¼ in., which places a restriction on the process for certain applications. Even this minimum thickness must be increased for long runs according to the graph shown in Fig. 6. Cast-weld construction can overcome this restriction. Whenever comparatively thin sections of large area are required in a casting, it is best to use rolled-plate sections which can be joined to the casting by welding.

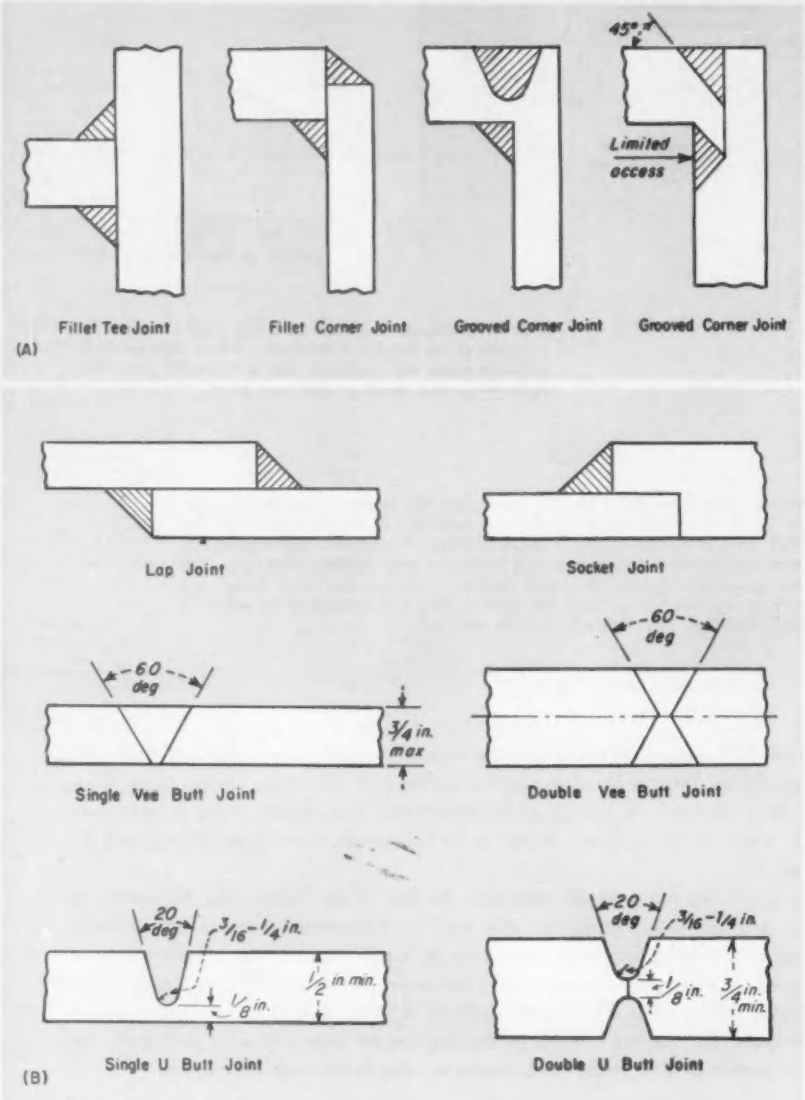


Fig. 7—Typical welded joints used in cast-weld construction. (A) Joints for members intersecting at right angles. Bevels or grooves may be cast. (B) Joints for members in line. In either case, joints should be located where welding will be a minimum.

WHEN TO WELD

There are three general conditions under which cast-weld construction should be considered—(1) when defects cannot be prevented by normal casting practice; (2) when more economical to weld together two or more easily-cast pieces of an otherwise complicated casting; and (3) when this method can make a piece more simply than by any other construction method.

To split a part into sections for casting and then welding appears to involve additional expense over casting in one piece. By a closer look, however, it will be observed that the process can actually result in considerable savings. Often a high reject rate for complicated one-piece castings can be cut to a negligible figure by splitting into sections and welding. Savings in cores, molds and patterns often tend to offset the cost of welding and in many cases more than justifies it on this basis alone. The large ribbed disk shown in Fig. 1 is an example where a better quality casting resulted at somewhat lower cost by welding the flange to the disk rather than casting in one piece. The two-piece construction eliminated a sectional core under the flange and simplified the molding job. Savings amounted to 6 man-hours per casting. Offsetting this, additional operations of fitting, welding and grinding totaled 4½ hours. (This is on a one-at-a-time basis and a larger production rate should show substantially greater saving.) Although the $10 saving per piece appears inconsequential for a 1,300 lb item, a sound casting was assured. This completely eliminated any repair welding, which could bring up the cost materially.

Aside from the elimination of defects, cast-weld construction is often justified: (1) When large, awkward coring can be eliminated or substantially reduced; (2) when long relatively slender castings are required; and (3) when there are details in the nature of attachments which would complicate molding of the main section or the drawing of a pattern.

The process of cast-weld construction provides a method of combining cast-to-shape advantages into weldments or obtaining large complicated castings of sound quality through the medium of welding.

WHERE TO LOCATE THE WELD

If there is a choice, the joint should be located where welding will be a minimum. Cost of stainless weld metal in place will average about $7 per pound. This often imposes an economic limit on the cast-weld process as well as weld repair. The type of joint and size of weld must

be adequate from a stress standpoint, but it is not economical or practical to make all welding joints look like part of the casting. The grinding of welds for appearance is seldom practiced in the fabrication of weldments from wrought materials, and there are few other reasons for structural welds to be ground in castings; yet this expensive practice persists.

The accessibility for welding and the fitting of the parts must also be considered in the location of the joint. A welder must be able to see the point of welding and at the same time be able to touch the bottom of the joint with his electrode angled not more than 45 deg from the axis of the joint. The fitting of rough castings for welding is complicated by the wrought casting tolerances and allowances left for machining. If there is a large duplication of pieces, a fixture should be worked out for tack welding so the relative position of the parts are located without measuring in assembly. Some casting parts are naturally self aligning, and the designer should incorporate this feature if possible. A good example of a self-aligning joint is a socket-type pipe joint. Some types of castings—particularly pressure types—require machining before welding, in which case the fitting problem is easier. In any case, drawings should show all information required for fitting as well as the exact size and design of the joint.

HOW TO WELD

There is only a minor difference between the weldability of castings and wrought material for the same analysis and that is the effect due to grain size. Austenitic and ferritic alloy-steel castings have a large grain structure which is not refinable by heat treatment. This large-grain structure in certain hot-short alloys make them more susceptible to cracking during welding than the fine-grain wrought product. They can be welded, but it is necessary to take greater precautions and use a restricted welding procedure. The weldability of the common stainless alloys, however, is not measurably affected by grain size.

Details of the welded joint must be considered. Fillet welds are the simplest. These are used to connect members which intersect at right angles; such as stiffeners and other attachments. No special edge preparation is required, but size of weld is important. The quantity of weld metal increases as the square of the fillet size, while the strength of a fillet weld is based on its throat section.

Most cast-weld construction concerns butt type joints. The two members may be in line or at right angles to each other. Butt joints of two equal thicknesses should have complete penetration and should be welded from both sides, if possible. Butt welds of pressure castings can usually be accomplished only from the outside; but there are special means of getting complete penetration. Bevel-groove joints are those commonly used for butt welding. Maximum practical depth of groove, beveled from only one side, is ¾ in.; considering economy of weld metal. When thicker material is encountered, the joint should be beveled from both sides. When a heavy flange is to be attached to a thinner section, the flange should be beveled only to a depth equal to the thinner section. However, allowance must be made for the amount of metal removed by machining so there is sufficient weld left for stress requirements. Bevels on castings may be cast or machined, but machining is an additional and usually unwarranted operation. A joint that is beveled from both edges should have a 60 deg groove; but when only one edge is beveled, 45 deg is preferable. Some typical joints used in cast-weld construction are shown in Fig. 7.

The metal-arc welding process, with coated electrodes, is generally used for stainless. Electrode manufacturers now offer 20 different alloy electrodes for chromium-nickel austenitic stainless steels and 5 for straight chromium steels. These electrodes are designed to chemically match the standard grades of stainless. Metal-arc welding is the most versatile method, and the quality of weld is equal to that of the base material. However, metal-arc welding is not suitable for automatic welding. When more than ten castings are involved and more than 2 pounds of weld per casting is required, automatic or semi-automatic welding should be considered. The automatic welding method most suitable for welding stainless steel castings is the inert-gas metal-arc process.

Automatic weld metal deposition rates are 2 to 4 times that obtained with manual arc welding and have the advantage of continuous deposition, which reduces the labor costs considerably. However, motorized welding positioners or special welding jigs are usually required. Considerable duplication of parts is generally required to make automatic welding worthwhile.

In welding austenitic stainless steels for corrosion-resistant applications, consideration must be given to intergranular corrosion. Except for the ELC grades and those stabilized with columbium or titanium, all weldments must be solution heat treated. This consists of water-quenching from about 2000 F—the exact temperature depending on the alloy. This operation is difficult for large sections and can result in distortion. Stabilized or ELC grades of stainless steel should be used in large cast-weld construction.

SUMMARY: The problems involved in obtaining high-quality high-alloy castings of complicated designs usually require an understanding of foundry techniques. Best results are often secured through cast-weld construction. All stainless alloys are readily weldable; most of them in the cast form as well as in the wrought. Properly made welds in castings will satisfactorily pass the most stringent X-ray and Zyglo-testing requirements.

Cast-weld construction usually results in savings in patterns and cores, and in many cases is used principally because of the economies involved. However, chief advantage is in elimination of shrinkage cavities, hot tears and misruns due to design difficulties.

The field of application of cast-weld construction touches only a small portion of the total production of steel castings. More cast-weld construction could be used to advantage but the field is generally limited to large or complicated sections. Cast-weld construction provides a wide design flexibility to take advantage of the simplicity and economy of casting-to-shape.

EDITOR'S NOTE: Although Mr. G. J. Gibson was associated with Cooper Alloy Corporation at the time the manuscript was submitted for publication, he is now with The Carpenter Steel Company, Alloy Tube Division, in Union, New Jersey.

Typical failure of a single cage one-way clutch (photo at right) in which individual sprags are not forcibly kept in phase. When oscillating torque load was applied, note that some of the sprags rolled over while others popped out from under their load in the release direction, making the clutch inoperative. Such malfunctions, even at low torque values, instigated research into • • •

. . . Full Phasing

H. P. TROENDLY

President and General Manager

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FOR ONE-WAY CLUTCH APPLICATIONS involving any appreciable degree of torsional oscillation and/or shock loading, conventional unphased clutches, including full complement types are often unsatisfactory. Under these conditions of loading, performance is often erratic and unreliable. In fact, frequent failures have been recorded with unphased clutches where the normal loading was far less—as much as 75 per cent less—than the rated capacity.

An intensive testing and research program carried on for the past several years indicates that the cause of a large proportion of these failures is a dephasing action of the sprags. Figs. 1 through 3 are reproductions of frames from motion pictures of a Borg-Warner unphased clutch, a full complement unphased clutch, and a conventional roller type clutch, taken in an oscillating torque loading machine.

A dephasing action, the results of which are similar to the effect of sprags walking out from under their load in a haphazard manner, occurs under shock loading condi-

TYPICAL APPLICATIONS

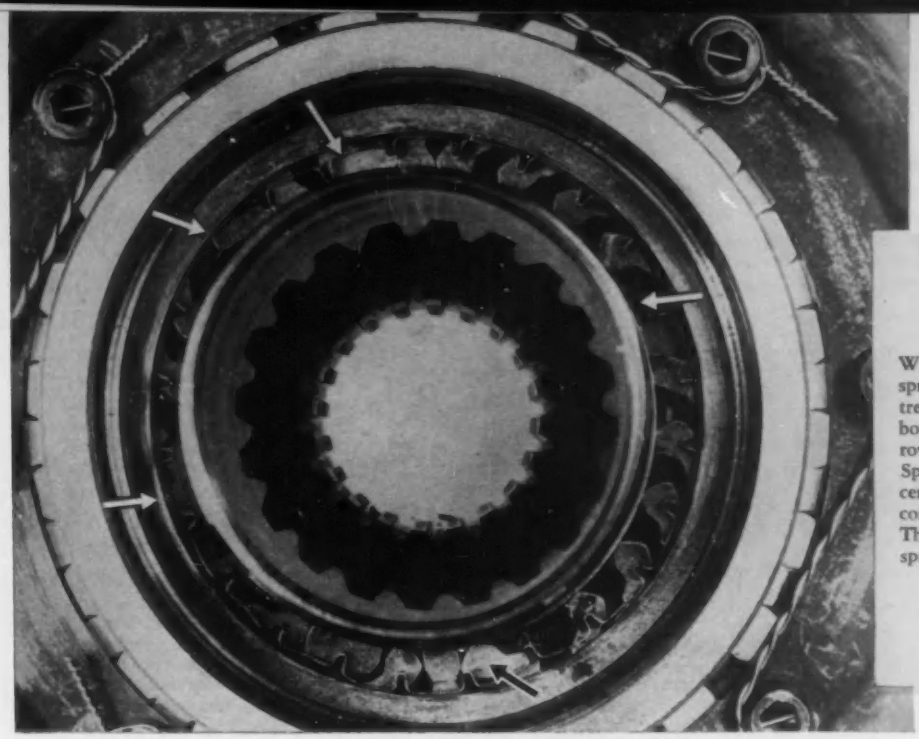
In the Hiller Helicopter Main Rotor Drive Shaft installation the very high torque loads—as much as 5400 foot pounds—with shock loading and torsional vibration after impact, as well as cold weather starting conditions, caused many of the original full complement type clutches to de-phase and slip or the sprags to turn over and lock. This imposed considerable inconvenience on the operators and premature tear-downs.

The Borg-Warner double-cage clutch has now been installed on almost the entire Hiller Helicopter fleet and all of the Military Helicopter fleet is now equipped with these clutches. Since this retro-fix program the new clutches have a total operating time in excess of 20,000 hours with winter operation involved and there have been no failures or mal-functions.

On the Reo-Timken type 2½ ton 6 x 6 Front Wheel Drive Army Truck all types of unphased clutches failed to give consistent life beyond 2,000 miles on a test track. Five of these 6 x 6 Army vehicles equipped with the Borg-Warner double-cage clutches are now operating over this same test track and have accumulated 185,900 miles without any difficulty whatever to date. Thousands of these rugged duty army trucks are equipped with these new double-cage clutches which have been in vehicles over a year with completely satisfactory results being reported.

In the AiResearch aircraft cabin supercharger compressor job, where, under certain conditions for long time intervals the load on the clutch oscillates 40 times per second through a 100 foot pound range, the special problems in this installation were solved with the double-cage clutch. Experience on the airlines during the heavy air-conditioning load this past summer has been without a single clutch failure. In this job, unphased sprag clutches performed erratically.

On the Bendix Jet Engine Fuel Air Starters where other types of one-way



WHITE ARROWS indicate sprags in various degrees of distress. Sprag at right of one at bottom dead center (see black arrow) has popped out in release. Sprag at left of bottom dead center has rolled over its coffin corner in the load direction. Thus, load is concentrated on sprag at bottom-center.

for One-Way Clutches

tions with unphased clutches. As a force is applied in a fraction of a second (shock loading), unphased sprags simply do not assume their loads in a uniform manner because of inertia forces, inter-sprag friction and lack of uniform positive energizing means. The results of this non-uniform loading action is that some sprags are overloaded and others are underloaded.

Many tests both in the laboratory and in the field, coupled with the study of the phenomena involved by use of the high-speed motion-picture camera, indicated the need for a full phasing type of one-way clutch where all sprags are mechanically forced to work in unison. Fig. 4 shows the operation of such a full-phased clutch design under conditions similar to those imposed on the three unphased types of clutches in Figs. 1 through 3. Note that, whereas the sprags have moved under the influence of torsional vibration, they have moved uniformly, remaining in a uniformly disposed position to maintain equal load distribution among all the sprags.

Fig. 5 is an exploded view of the production design for a full-phased, double-cage clutch. The most important characteristics that makes this full phasing clutch reliable

clutches had proved entirely unreliable, the problem was solved with the double-cage, full-phased clutch incorporating a centrifugal throw-out feature. A clutch was developed which operates from minus 65 F to plus 160 F and over-runs at 8500 RPM, essentially without lubrication due to the temperature range imposed.

On another Jet Starter project at Hamilton Standard Division, a double-cage, full-phasing clutch of similar construction employing the centrifugal throw-out feature has passed very comprehensive tests which involve the same low temperature and over-running speeds of 14,000 revolutions per minute.

DEFINITION OF TERMS

- One-way clutch—A device that transmits rotary power in one direction only. It drives when the speed of the driving race equals that of the driven race and free wheels when the speed of the driving race is less than the driven race.
- Energizing force—The force that keeps the sprags in contact with both races so that they will engage when needed. Commonly accomplished by spring action imposed upon all the sprags.
- Full complement clutches—Those units in which the annular space between the raceways for receiving the sprags is circumferentially filled and with only working clearance between the sprags.
- Full phasing—Where all the sprags of a clutch are compelled by positive means—other than spring force—to engage simultaneously and to maintain their position accurately. Each sprag is thus controlled and forced to carry its proper share of the work load or abuse.
- Dephasing—A phenomenon that occurs when certain individual sprags or rollers back off from under their load, thus transferring their load to adjacent members.

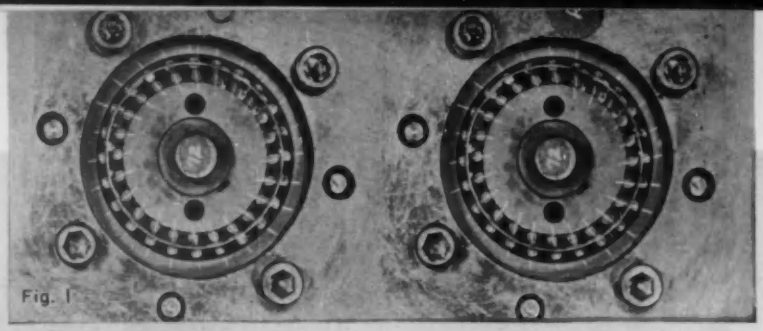


Fig. 1—Dephasing of a single cage type one-way sprag clutch under a torsional load. Photograph at left shows the clutch preloaded and sprags and races marked. The right-hand photograph shows the amount and variation of sprag dephasing after 60 sec of oscillating torque.

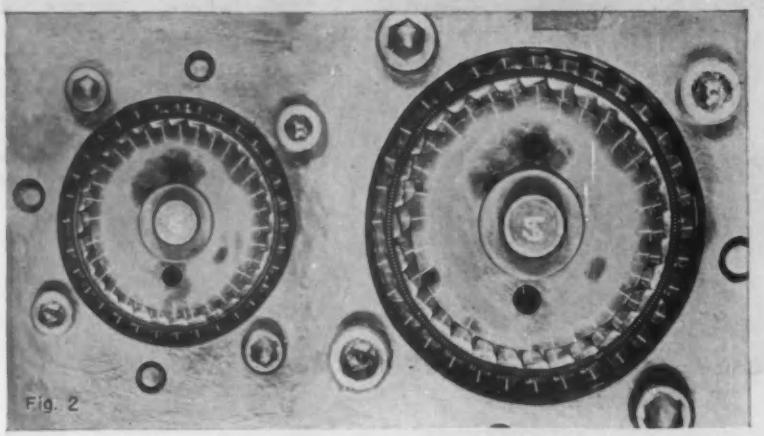
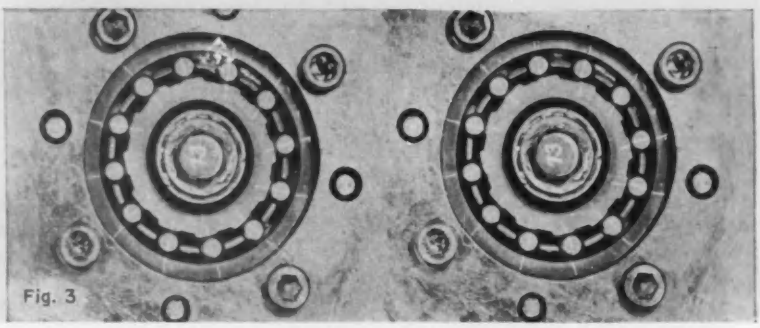
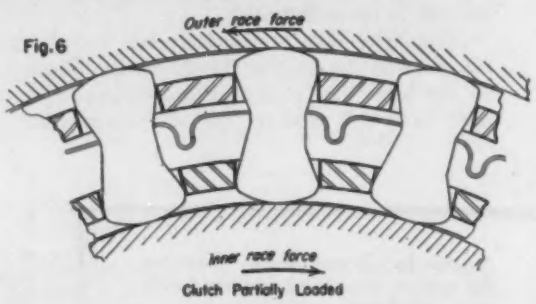


Fig. 2—Dephasing of a full complement type sprag clutch under a torsional oscillating load. Photo at left shows the clutch preloaded and marked; the one at right shows the amount of dephasing after 60 seconds. Full complement clutch has sprags filling the entire space between races.

Fig. 3—Dephasing of a caged roller type one-way clutch under a torsional oscillating load. At left is a clutch preloaded and marked. Illustration at right shows the amount of dephasing after 60 seconds. Note the random manner in which the rollers have started to dephase.





is that all sprags are compelled by positive means—other than spring force alone—to engage, disengage and accurately maintain their relative positions under all conditions. The close-fitting windows which are perforated in accurate circumferential relationship in the outer and inner cages fit the two opposite sides of the sprags near the outer and inner operating faces very closely at the free-wheeling or energizing point, and at the mean load point, as well as the full load position. This is accomplished, see Fig. 6, by having contours developed on the sides of the sprags somewhat like the contour of an involute gear tooth, and has the net effect of harnessing all sprags mechanically together so that they must operate in controlled uniformity at all times. Each sprag is, therefore, controlled and forced to carry its proper share of the load or abuse throughout the working range of the clutch.

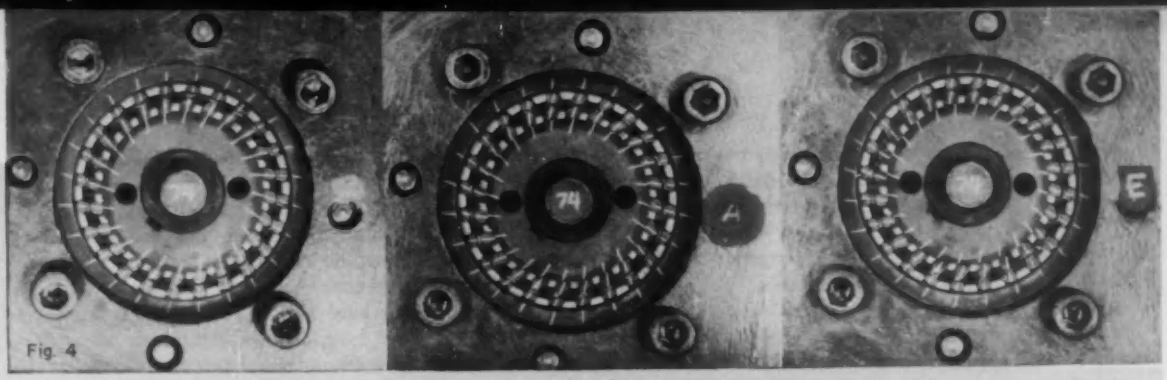


Fig. 4—Double-cage, full-phasing one-way clutch subjected to a torsional oscillating load. Shown at left is the clutch preloaded and marked; center view illustrates sprags after 60 sec of loading; and right-hand photo is after 5 minutes. Note that all sprags have walked about ¼ the thickness of a sprag. All sprags are still carrying their equal portion of the load since they are all still in phase.

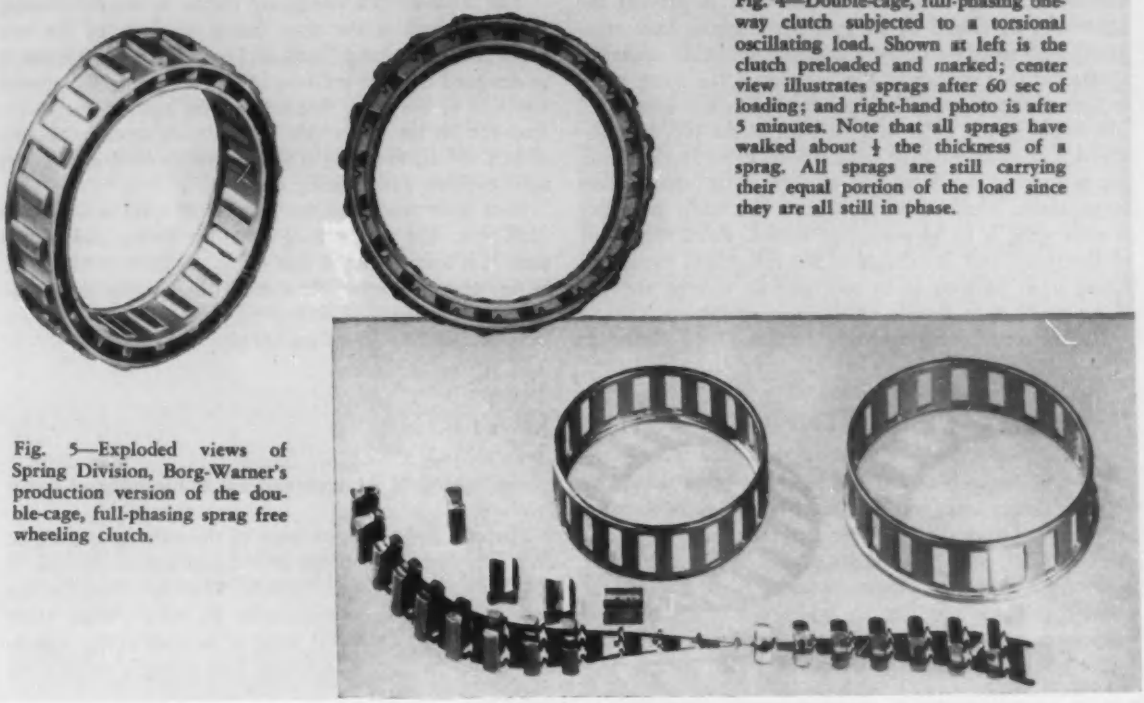


Fig. 5—Exploded views of Spring Division, Borg-Warner's production version of the double-cage, full-phasing sprag free wheeling clutch.

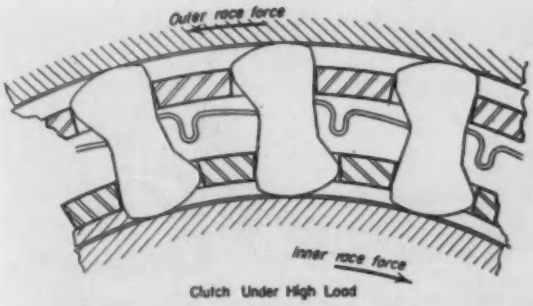


Fig. 6—Cross-section views of a segment of a double-cage full-phasing clutch showing from left to right the relationship of the sprags and cages in the release, (free wheeling) partially loaded and fully loaded position. Note how close fit of the contoured sides of the sprags in the cage windows forces relative rotation of the cages, thus assuring that all sprags move in phase throughout their operating ranges.

FACTORS WHICH DEPHASE THE SPRAGS OF A CLUTCH

Many one-way clutch applications combine shock loading, torsionally oscillating loads and stiffening of the oil film because of low temperature. In every installation the problem of the races and sprag faces becoming polished by free-wheel wear is present. As this occurs, the coefficient of friction is reduced and phasing becomes even more important than with a new clutch. If slippery compounds are incorporated in the lubricant as occasionally happens, phasing is even more critical. Viscosity increases at low temperature operation reducing the possibility that the sprags will function as designed, unless they are forced to phase together by some simple, but sturdy mechanical means.

When the design of the clutch is such that the sprags

are in contact with each other and, therefore, rub against each other during the loading and unloading action, they are prone to be erratic in loading. Intersprag friction and sprag inertia forces can over-ride a light spring energizing force and prevent good phasing of a clutch as it loads up under a shock load application. Likewise vibration and impact forces acting on the clutch unit makes it difficult for the sprags to phase into uniform engagement at the instant of load application.

End plate friction—when sprags rub and wear into end plates which must be close fitting to keep sprags from skewing—introduces a force which tends to prevent the light force developed by the garter-type spring from energizing each sprag for uniform engagement. Also, when the sprags bunch together at the bottom of the sprag space so that all the clearance between the sprags is concentrated into a gap in the order of $\frac{1}{8}$ to $\frac{1}{4}$ in. at the top, an additional inter-sprag wedging force is introduced further tending to prevent the energizing of each sprag into uniform engagement. Uniform enagement is absolutely necessary if each sprag is to be uniformly loaded. Axial alignment of the sprags and the design of the sprags and energizing spring must be such as to minimize or prevent skewing if the clutch is to operate under these conditions.

In full complement clutches, hardened end plates are closely fitted against the ground ends of the sprags in an effort to prevent skewing. Because of the small circumferential dimension across the sprag ends, there is a limit to the effectiveness of this method. All sprags are not always ground to exactly the same length, allowing a variation between the end fit of the sprags and the plates. Clutch failure investigations have shown gouging and wear between sprag ends and the end plates. This is an indication of one of the detrimental forces which tends to counteract the spring energizing force and causes sprag dephasing under severe conditions of loading and vibration.

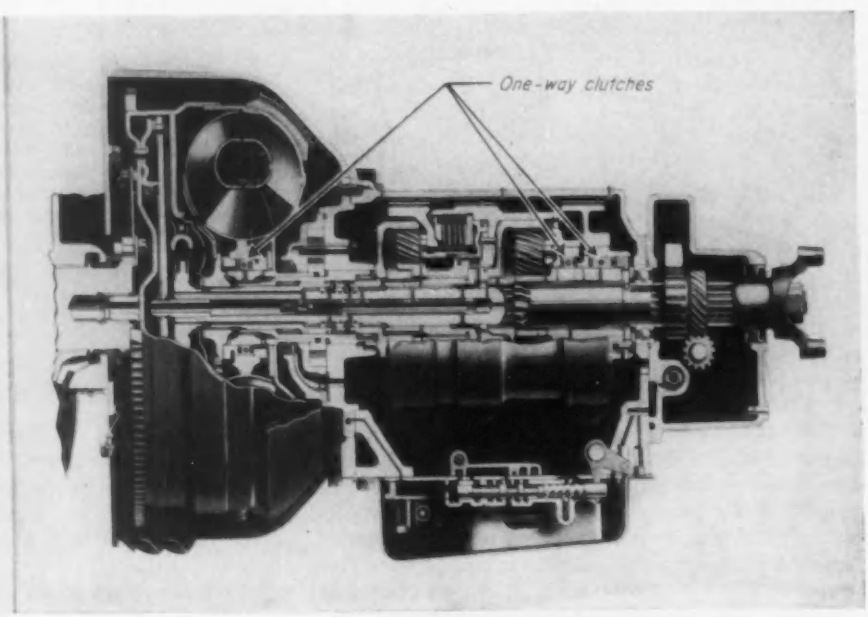
The triple-wrinkle energizing ribbon of the full-phasing clutch, as well as the close fitting windows of the two cages, keep the sprags in axial alignment. The ribbon is so designed that the pressure of the energizing tab against one side of the sprag forces the sprag against the square cross-bar on the other side of the sprag opening in the ribbon. Thus, the sprag is always flexibly held in a proper axial position under spring tension.

Race taper also enters the problem of sprag skewing and dephasing. On the basis of extensive testing and experience, it is recommended that race taper be held to 0.0002 in./in. of race length. Race section symmetry should be such that as the load is applied to the component, the races do not bell-mouth excessively.

FACTORS AFFECTING CLUTCH OPERATION

Research has determined that more attention should be given to proper cross sectional areas for the races to withstand hoop forces that the sprags impose on the races as the clutch is loaded to ultimate capacity. The outer race of a clutch is a very elastic element. Beyond a certain point it does no good to add additional sprags between weak races, since the controlling resisting force that determines torque carrying capacity is the hoop strength and rate of stretch of the race—and not the number of sprags involved.

The core and the outer areas of the outer race must be ductile enough to be tough and of high elastic strength to obtain maximum torque capacity. Core hardness, for the outer race, should range between R_c 43-48. Heat treatment should be such that there is no undesirable transistion zones between the tough high-strength outer areas



The Studebaker type of automatic transmission (left) designed and built by Borg-Warner and the Fordomatic and Merc-O-Matic automatic transmissions (right) being built by the Ford Motor Company and by Borg-Warner, use many thousands of Borg-Warner one-way clutches daily. These clutches have built up a good record of performance in all these automatic transmissions.

and the harder pressure face areas of the races. Similar values apply to the material used for the core of the inner race.

The pressure faces of the races—the area against which the sprags slide and press—must be hard to resist free-wheel action and pressure wear or indentation. Similarly, the depth of the hardened case face of the races is important since the sprags impose high local pressures against the raceways. Brinnelling must be avoided. The sprag wearing faces of the races should be about R_c 62 hard. Suitable bearings must be provided to maintain and control the space between the races if minimum free wheel wear and reliable high torque carrying capacity is to be obtained.

The design of the clutch package must be such in connection with the races and bearing spacing parts, that these elements operate concentrically. Eccentricity induces free wheel wear and reduces torque carrying capacity since it forces variation of the sprag space from one side of the clutch to the other. The higher the torque and the higher the free wheel speed, the more important it becomes to control and limit the value of "total run-out" as well as to control the basic sprag space tolerances.

SPRAGS DESIGNED TO CENTRIFUGALLY LIFT-OFF

Centrifugal lift-off of sprags minimizes the free wheel wear on the inner race. This has been attempted with both types of clutches—full complement and full phasing. The full complement design, however, has certain characteristics which tend to counteract centrifugal lift-off. For instance, inter-sprag friction, sprag rubbing and wearing on end plates, and the fact that the sprags can bunch together at the bottom of the raceway under gravity and vibration, all tend to interfere with proper centrifugal lift-off characteristics of the clutch in operation.

On the other hand, the action of the energizing ribbon on the sprags and the spacing and aligning characteristics of the two phasing cages makes for a well controlled, uniform, centrifugal lift-off action in the double-cage construction. Each sprag acts against its own accurately tensioned spring tab. The ribbon and the cages keep all the sprags spaced and in proper position to function properly at the lift-off point. With the two cage construction, all sprags are phased so that they lift-off and come back on the races at the selected speeds.

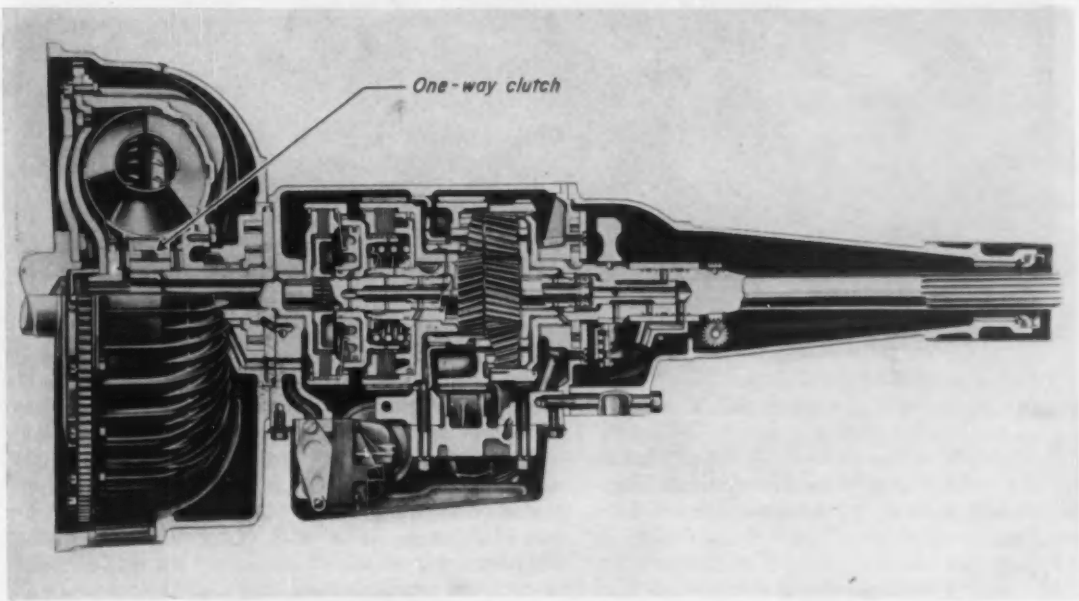
CONCLUSIONS

From the foregoing, several conclusions can be stated with regard to full phasing clutches as opposed to other one-way clutch units.

RELIABILITY. Full phasing units have better characteristics where shock loading and torsional vibration are encountered.

CAPACITY. Since uniform load distribution of sprags is forced by the phasing characteristics of the cage construction, higher rated torque carrying capacity for a given safety factor can be attained.

PRODUCABILITY. Relatively simple and inexpensive to produce since sprags are accurately drawn wire shapes; energizing ribbon is a precision stainless steel stamping; and cages are heat treated, drawn rings with sprag phasing holes punched. There is considerable saving over roller clutch free add dash wheel units since no complicated ramps or cam surfaces are needed.



Another Engineering Material . . .

FIBROUS TEFLON

Teflon fiber is a new tool in the concept of considering fibers as raw materials used to solve technical problems in industry. It offers the possibility of new end uses, together with outstanding performance in those applications where fluorocarbon properties are required of fabric components such as gaskets and belting.

B. S. FARQUHAR

Textile Fibers Department, E. I. du Pont de Nemours & Company

Continuing research in the du Pont laboratories has resulted in the development of a sixth synthetic fiber—tetrafluoroethylene polymer in continuous filament form. The remarkable combination of properties exhibited by this fiber prompted chemists to call it Dragon's Fur because it is one of the most chemically resistant fibers known, and has excellent stability at elevated temperatures. *Teflon tetrafluoroethylene fiber* is the official name of the new synthetic.

At present the fiber is being produced in a semi-works on an experimental basis. It is being sold to industry for evaluation in critical end uses to establish performance-to-cost relationships and to assess market potential as a basis for determining advisability of ultimate commercial manufacture on a large-scale basis.

Table I—Properties of Tetrafluorethylene Fiber

Property	Range	Value and Comment
Specific gravity	High	2.3
Tensile strength at 75 F	High	44,200 psi
Elongation at 75 F	Medium	24 per cent
Wet strength	Excellent	Equal to dry strength
Transverse strength	Excellent	Dry and wet, loop and knot tensile strengths 32,000–39,000 psi
Range of flexibility	Good	Non-brittle in range from −100 to 500 F
Elastic modulus at 75 F	Medium	442,000 psi
Zero strength temp	High	590 F
Gel temperature	High	621 F
Decomposition temp	High	750 F
High temp decomposition rate (weight loss)	Low	1½ per cent/hr at 806 F 0.0002 per cent/hr at 554 F
High temp dimensional stability	High	Can be heat stabilized, non-brittle, good flex and abrasion properties
Chemical stability	Excellent	Affected only at high pressures and temps by fluorine and chlorine trifluoride gases and molten alkali metals
Useful chemical environment	Diverse	No known solvent; can be boiled in aqua regia, fuming or fortified mineral acids, concentrated alkalis
Flammability	Non-flammable	Melts with decomposition
Moisture absorption	Zero	
Wettability	Low	Most non-wettable of known fibers
Adhesiveness	Low	Few materials stick with any real degree of adhesion
Coefficient of friction	Low	Dynamic 0.28; static 0.20
Electrical properties	Good-to-excellent	Bleached yarn shows better properties than unbleached
Color	Brown	Can be bleached white by boiling in strong mineral acid or prolonged exposure to high heat
Dyeability	Poor	Can be stained by acetate colors
Nature of "feel"	Soft and slippery	

Table II—Projected End Uses for Teflon Fiber

- Packings for pump and valve shafts
- Gaskets for flanged piping and other joints
- Laundry textiles for press and roll covers and pads
- Special conveyors and beltings
- Electrical tapes and wire wraps
- Electrolytic anode bags and diaphragms
- Hose and V-belt curing tapes
- Liquid-filtration fabrics
- Gas-filtration fabrics
- Special roll covers
- Diaphragms for valves
- Screen printing fabrics
- Dye bags
- Printing back grays

COMPARISON WITH TEFLON RESIN. The remarkable chemical inertness and heat resistance of Teflon tetrafluoroethylene resin in the form of plastic materials, dispersions, finishes and coated glass fabrics are well known. The new fiber exhibits these same chemical and thermal properties, but is also characterized by *additional physical properties* and represents a *new physical form* of fluorocarbon compound.

The more important properties of Teflon fiber are listed in Table I. In general, they suggest industrial rather than apparel end uses as listed in Table II. All of these end uses are predicated on the fact that the fiber will show sufficiently long life so that, when this performance is measured against cost, economies will result to the end user or performance will be obtained in end-use applications not possible within the limitations of other fibers.

Based on preliminary field performance tests, end-use field performance testing of woven fabrics is being broadened to obtain a comprehensive picture of performance not only within the varying environmental conditions of a particular end use, but also under conditions fundamentally characteristic of different end uses. For example, heat and chemical resistance, long flex life, good abrasion resistance, anti-stick properties, good strength, nonflammability, and low coefficient of friction should be of value in many gas and liquid filtration applications. In addition to these, there are packing and gasketing, roll covering and conveyor uses where severe environmental conditions exist.

In packings for pump shafts, valve stems and reciprocating rods, Teflon fiber is already performing well. Examples of this performance include the following:

(a) Reciprocating pump handling CH_2O and H_2SO_4 at pressures well in excess of 4,000 psi is still satisfactory after 1,800 hr in service; best previous packing lasted 330 hr. Made possible the operation of a completely new continuous chemical process.

(b) Centrifugal pump transferring molten urea at 130 C. Satisfactory after 34 days in service; best previous packing life was two to five days.

(c) Acid reclaim valves passing dilute H_2SO_4 at 170 F.

Table III—High Temperature Properties of Teflon Fabric

Test temp, F	Breaking load at test, lb/in. of fabric	Tenacity, gpd*	Breaking elong, per cent
70	90.0	1.40	64
200	25.0	0.39	33
300	15.0	0.17	27
400	13.3	0.15	25
450	12.3	0.14	22
475	11.7	0.13	22
580	——	0.10**	——
590	Zero Str Temp	0.10**	——
620	Transition Temp	Solid Gel	——

* Grams per denier, calculated from fabric strength, except where indicated.
** Measured on filaments using zero strength tester.

Table IV—Physical Properties of Teflon Yarn

Test temp, F	Tensile strength, psi	Elong at break, per cent	Elastic Mod (approx), psi
−85	71,000	11	900,000
32	58,000	17	580,000
75	44,000	24	440,000
300	9,800	22	39,000
390	8,300	19	33,000
536	6,500	17	27,000

Table V—Room Temperature Properties of Teflon Fibers After Exposure to Hot Corrosive Liquids

Conditions	Denier	Tenacity, gpd*	Elong, per cent
Control	8	1.9	31
Conc H_2SO_4 5 min bleach at 550 F	13	1.1	95
Conc $H_2SO_4 + HNO_3$ 4 hr at 320 F	11	1.2	65
25 per cent Caustic 4 hr at 240 F	11	1.4	83

* Grams per denier.

Table VI—Service Temperature Shrinkage of Preshrunk Teflon Fabric (Fabric first preshrunk while relaxed at 600 F for one minute)

Time at *Service* Temp, hr	Accumulative Shrinkage, per cent			
	At 400 F		At 500 F	
	Warp	Fill	Warp	Fill
48	0.2	1.0	2.6	3.0
96	0.6	1.4	3.1	4.1
192	1.1	2.2	3.2	4.2
384	1.1	2.5	3.5	4.2

Inspection after seven months showed no deterioration; two to three weeks life for blue asbestos.

In addition to having twenty times greater tensile strength than the tetrafluoroethylene resin, the fiber has better sealing characteristics (less creep) in packing applications. Operation on centrifugal shafts at peripheral speeds of 1,000 fpm has been demonstrated thus far. The fine fiber structure is apparently conducive to the development of a resilient braided packing that conforms to the shape of the gland at relatively low pressures. The low coefficient of friction of Teflon fiber is also important in application such as packings.

For liquid filtration, Teflon has outstanding chemical resistance. This property, coupled with heat resistance, good strength and abrasion resistance, anti stick characteristics (for easy filter cake discharge) and complete lack of brittleness, indicates much promise in the filtration field.

Fabrics of the new fiber are inherently non-wettable, even less so than polyethylene. This non-adhesive characteristic, coupled with chemical and heat resistance, points to applications in special conveyor belts for hot, sticky and/or corrosive materials. The same characteristics could be capitalized in roll covers.

Heat resistance is, of course, one of the most important characteristics of Teflon and many of its projected uses are based on the combination of heat resistance with other properties. For example, in gas filtration service, temperatures of 400 to 500 F appear to be feasible. The nonbrittle nature of the fiber is of importance in the shaking operation when cleaning the filter cloths. Abrasion resistance is actually improved by heat exposure.

CHEMICAL INERTNESS. Tetrafluoroethylene fiber can be boiled in concentrated sulfuric acid, fuming nitric acid, concentrated lye, practically all salt solutions, even in aqua regia. A fabric bag of Teflon fiber has been used to dissolve out metallic contamination from particles of Teflon resin by immersing in fuming nitric acid. Though there is no known solvent for this "Dragon's Fur," molten alkali metals such as sodium, and fluorine or chlorine trifluoride gases under elevated pressure and temperature, do affect the fiber to some extent.

HEAT RESISTANCE. There is no chemical degradation of the fiber up to temperatures of 400 to 425 F. At about 550 F, decomposition products are lost at the rate of two parts per million per hour. This rate is higher at 800 F, but only amounts to about 1.5 per cent weight loss per hour, and is accompanied by whitening after extended exposure. A temperature of 525 F is generally considered the maximum long-term limit.

The Teflon polymer (polytetrafluoroethylene) is not poisonous. It has been used extensively in industry for many years without being identified as a causative factor in any fatalities, either directly or by pyrolysis. But, when heated above 400 F, it does give off toxic gases and continued caution is necessary. Up to the gel temperature (621 F), forced ventilation is generally adequate and special care to avoid direct breathing of the vapors will keep working conditions within safe limits. Above this temperature, Teflon yarn reverts to massive form and loses all its fibrous properties.

EFFECT OF HEAT. The fiber tends to relax on the first exposure to high heat. This results in a measurable increase in elongation and a reduction in tensile strength of the fiber, depending on time of heating. The fiber and fabrics made from it shrink as a result of the relaxation. Subsequent exposures to the same degree of heat show very little additional change in either strength or shrinkage properties.

As can be seen from Table III, Teflon fiber softens at high temperature but retains useful fabric strength to more than 400 F, and for some applications in excess of 500 F. Values for the tensile strength of continuous filaments at elevated temperatures are shown in Table IV. At 390 F, the fiber has only about 20 per cent of the strength measured at room temperature; at 536 F, the tensile strength values are not appreciably less than at 390 Fahrenheit.

It should be noted that, even at 475 F, the fabric of Table III has about one-fourth the room temperature strength of new wool on a volume basis. A Teflon fiber fabric of suitable weight and construction should therefore be serviceable for most high temperature uses. It maintains its strength after long exposure at high temperatures, even though properties measured at these temperatures are lower due to softening than those measured at room temperature.

As an example of long-term high temperature durability, a fabric heated at 482 F showed a 15 per cent loss in tensile and 28 per cent gain in elongation after the first 15 min of heating. No further change in properties occurred on subsequent heating for 144 hours.

The flex-abrasion durability (freedom from brittleness) of Teflon fiber is superior to that of rayon and Orlon acrylic fiber at room temperature, but inferior to nylon and Dacron polyester fiber. Under adverse chemical conditions, or at elevated temperatures, there is no fiber which can approach the flex-abrasion durability of Teflon. Exposure to heat actually improves flex-abrasion measured at room temperature. Initial flex-abrasion at elevated temperature would probably improve under conditions of continued heating.

Decrease in tenacity and increase in elongation as indicated in Table V for examples exposed to hot chemicals is due entirely to heat relaxation.

EFFECT OF HEAT ON STABILITY. For use in high temperature environments such as gas filtration, shrinkage must be controlled. Extensive tests indicated that most shrinkage occurs in the early stages of exposure. For example, at 450 F, half of the shrinkage measured after 19 hr occurred in the first 30 sec. In addition, if sufficient time is allowed, no further shrinkage will occur, provided the temperature is not raised. At 400 F, about 11 per cent shrinkage occurred after 138 hr but no further shrinkage was noted after 400 additional hours of heating. This behavior suggests that fabrics may be preshrunk at temperatures in excess of contemplated service temperatures to yield dimensionally stable fabrics at the prescribed service temperature.

Laboratory tests indicated that fabrics could be made dimensionally stable at elevated temperatures by a relaxed preshrinkage treatment at 600 F for one minute. Table VI shows the high degree of dimensional stability commercially obtainable with the new fiber.

It appears possible and advisable to heat stabilize fabrics for high temperature environments, such as gas filtration, diaphragms, and certain liquid filtrations. In addition, the use of preshrunk sewing thread is recommended. Again the preferred procedure is to preshrink under relaxed conditions (in skein form).

PROCESSING TEFLON FIBER. Napping or sueding of continuous filament twill fabric, on the side where the filling floats predominate, yields a fabric that will show minimum back pressure when used as a gas filter. The construction must be adjusted in the loom to produce a fabric which, after finishing, will have the required gas permeability.

Liquid-filter fabrics in temperature environments of 212 F or less will not require preshrinking. On the other hand, in the filtration of liquids such as oils, where temperatures are higher, preshrinking would probably be most advisable.

To obtain a size suitable for braiding, Teflon fiber will require plying several ends of the filament yarn. This is already being done by commercial throwsters in those cases where gasket and packing manufacturers have no facilities of their own. Though the dry braided yarn has shown unusual performance in packings, some manufacturers prefer to impregnate the braid with tetrafluoroethylene resin dispersion or with other materials commonly used. Gasket fabrics of Teflon can also be impregnated in this manner.

As noted above, Teflon fiber exhibits poor adhesion to a variety of materials. Non-permeable coated fabrics useable as valve diaphragms, for example, are possible through the use of open weave fabrics. These permit strike-through of the coating material from one face to the other and allow welding through the fabric interstices, thus providing a satisfactory bond. Open mesh fabrics of Teflon fiber have been coated with both Kel-F and certain of the silicones. In all cases, the bonding characteristics were satisfactory.

AVAILABILITY OF TEFLON FIBER. At present, 400 denier yarn with 60 filaments is being produced experimentally. Higher and lower denier counts and possibly monofilament yarns are planned for small-scale production in the near future.

As yet there is no staple fiber available. However, a fiberstock material can be made available in limited amounts for evaluation in certain end uses. Spinning of this fiberstock and of staple fiber into yarns is under investigation.

Sale of the present experimental production of Teflon tetrafluoroethylene fiber in continuous filament form and end use evaluation are being handled by the Industrial Sales Development Group of du Pont's Textile Fibers Department in Wilmington, Delaware.

Acknowledgement—The assistance of the various research groups of the du Pont Textile Fibers Department is hereby acknowledged. Credits are also due to those industrial firms who assisted in the initial preparation of fabricated articles and their service testing over extended periods.

TECHNICAL NEWS

1955 CHRYSLER NEW YORKER DELUXE, four-door sedan. Besides lowering the hood considerably, the new front and treatment features the "box check" grille element on all Chryslers. The New Yorker is 3.2 in. longer and 1.9 in. lower than the 1954 model. The Imperial and New Yorker models have a V-8 engine using a four-barrel carburetor and dual exhaust system. Horsepower is 250. The new V-8 in the Windsor turns up 188 hp., compared to last year's 119 hp.

PLYMOUTH'S BELVEDERE hardtop coupe is 10.3 in. longer and 1.6 in. lower than the same 1954 model. The headlights are shrouded, and the grillework is limited to a single horizontal bar. The windshield glass area has been increased about 16 percent. Horsepower of Plymouth's new Hy-Fire V-8 engine is rated at 177.

DeSOTO'S FIREFLITE SPORTSMAN hardtop coupe is more than three inches longer and 2.6 in. lower than the 1954 model. The Fireflite V-8 with a four-barrel carburetor develops 200 hp, while the Firedome V-8 with a dual throat carburetor, has 185 hp.

THE DODGE CUSTOM ROYAL LANCER hardtop is more than 16 in. longer and 1.2 in. lower than the 1954 model. The Super Red Ram V-8 turns out 183 hp, up from 150 hp. An optional four-barrel carburetor will bring the horsepower up to 193.

Chrysler's New Line

The disgruntled baseball fan's usual comeback of "wait until next year" has never been used as much as it has in Detroit this past year—only this time the remark came from the people at Chrysler Corp., and they were talking about cars, not baseball. This all started as a result of the sales licking Chrysler has been taking from General Motors and Ford. In 1953 Chrysler had almost 21 percent of the automobile market. So far this year it has dropped to about 12 percent.

With this as a good "reason why," the promotion campaign had it that Chrysler's 1955 line would mark a "complete departure from the previous ultra-conservative stylings." (The person responsible for this change was Director of Styling, Virgil Exner, formerly with the Raymond Loewy group noted for its work on the Studebaker a few years ago.) With a style that would appeal more to the public, Chrysler expects to recapture the 20 percent of next year's market.

The sales talk for 1955 will stress style completely, rather than the performance, horsepower, and other themes used in the past. However, the

chances are that the 250 hp. V-8 engine in the Imperial and New Yorker models will be brought into the sales argument more than once.

While the entire line of cars has retained a bit of its conservatism, the most obvious exterior changes will be noticed in the Studebaker like grille treatment on the Chrysler, the reshaped hood panels, and the chrome on the side and rear quarter panels. All of the cars from the Plymouth to the Chrysler have been lowered and lengthened considerably.

The big change inside, on all of the cars equipped with Powerflite, is the new location of automatic transmission selector lever. It has been moved from the steering column to the instrument panel "with the other infrequently used controls such as the ignition, headlight and windshield wiper switches," according to a Chrysler spokesman.

Metallurgists, Producers, Fabricators, Discuss Titanium Problems

About 250 government officials, titanium producers, parts fabricators, and airplane manufacturers got together in Cleveland recently for the National Aircraft Standards Committee symposium for titanium parts. High point of the discussion, sponsored by the Aircraft Industries Association of America, Inc., was an announcement by J. H. Garrett, Chairman of the Defense Departments titanium committee, that his department was negotiating a $1-million contract with Battelle Institute to cover many phases of titanium research.

Under terms of the contract, Battelle will conduct research and coordinate existing research programs. Battelle's work will be checked by a special steering committee, set up by the Defense Dept., and staffed by representatives from the various armed services. Battelle will not undertake any long-range research of its own under this contract, but will act as a trouble-shooter for short range problems which come up in the refining and fabrication of titanium and its alloys. As Garrett describes it, Battelle will attempt to "fill in the gaps as they appear." The new contract will in no way interfere with existing titanium research programs.

Research information developed by Battelle will be distributed through the Defense Dept. to a special list in industry, comprising those firms working directly under prime government contracts using titanium.

Length of the contract is 18 months, and is expected to be renewed at the end of that time.

No definite plans were made for the approach Battelle will take; research will be set by problems which individual companies bring in. Chances are that some of the major areas will be: how to heat treat titanium alloy sheet without causing embrittlement; how to heat treat extruded bar stock in the form of bolts; what specifications should be set to eliminate the wide variations in the purity and hardness of titanium sponge; the effects of hydrogen on titanium at elevated temperatures; and the demand by bolt makers for design criteria on fasteners.

Garrett predicted that titanium sponge, now being produced at a level of 5,000 tons annually, will be boosted to 30,000 tons annually within three years; but with the price remaining about the same, use of titanium for civilian goods is not expected in the near future. Two ways mentioned for cutting costs in the use of titanium: (1) Simply by increasing its usages; (2) Efficient scrap recovery.

An ordnance official disclosed that tests have been run on titanium as armor plate, starting with a sponge of 125-140 Brinnell hardness. This material showed a 25 percent weight savings over the ordinarily used alloy steels, and was equally effective. Other eventual military uses for titanium may be on ships where corrosion is a big problem. Use here will be as a cladding on steel--mostly for deck gear.

"Idea" Show Helps Small Manufacturer

Using the slogan, "New Business and More Jobs for Michigan," a number of city, state, and federal organizations got together in Detroit recently in an attempt to help the small manufacturers in that area weather the economic storms that hit the larger manufacturers. Officially titled the "New Products, New Methods and Patents Exhibit," the show included over 100 displays by some of the biggest names in American industry. In addition, the U. S. Departments of Agriculture, Commerce, Interior, Army, Navy, and Air Force sent exhibits, as did the Atomic Energy Commission and the Small Business Administration.

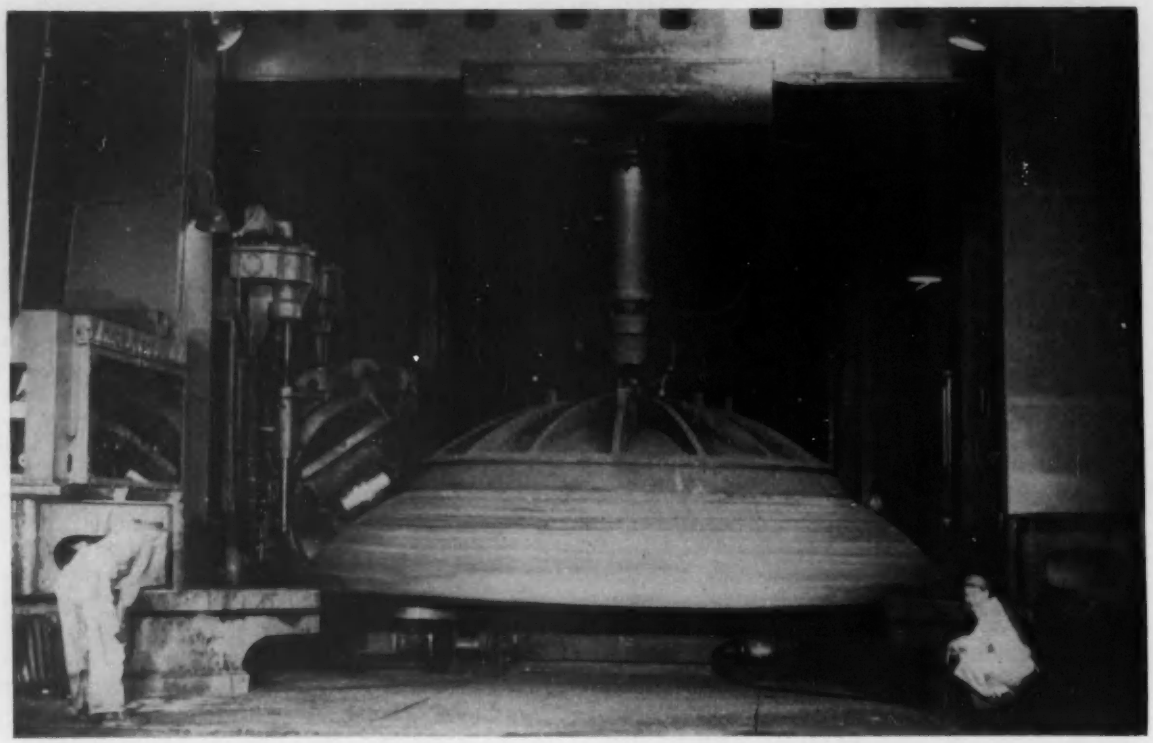
Michigan's officials say that of the 15,000 manufacturers in the state, more than 3,000 of them have no end product. They supply automobile manufacturers, or some other large industry, with components which eventually will go into somebody's end product. However, when the large company has a bad year and sales fall, the small manufacturer is the first one to feel the pinch. The show's sponsors agreed that if the small companies would diversify, and have a secondary product to which they might turn when production of the main product is cut back, the result would be a stabilization of the states industry and employment. By getting these large companies together, and in a position to give the small manufacturer some hints for new products, state and city officials felt that it would go a long way in helping to solve the business and labor problems in that area.

Few actual end products were shown. The displays concentrated primarily on industrial raw or semi-finished materials, available for use in end products. Under New Methods were displays of electronic testing and measuring devices, packaging containers & methods, new materials handling machinery, and timing devices.

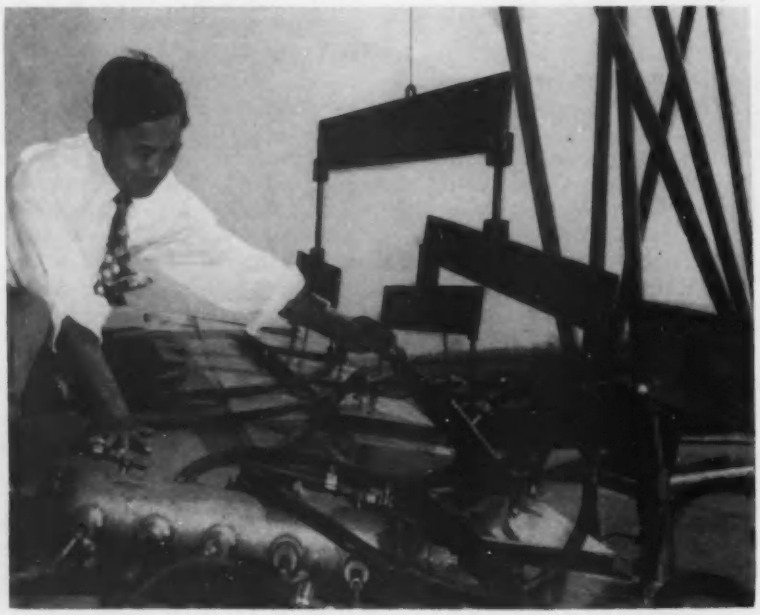
The Bureau of Patents had available a list of patents which could be used, free of charge, by any interested manufacturer. The Bureau of Standards showed films of "Project Tinkertoy," and demontsrated the use of printed circuits in various electronic devices.

Plans are being made to repeat the show next year. The opinion is that such a show should be presented where there is a surplus of skilled labor and manufacturing facilities.

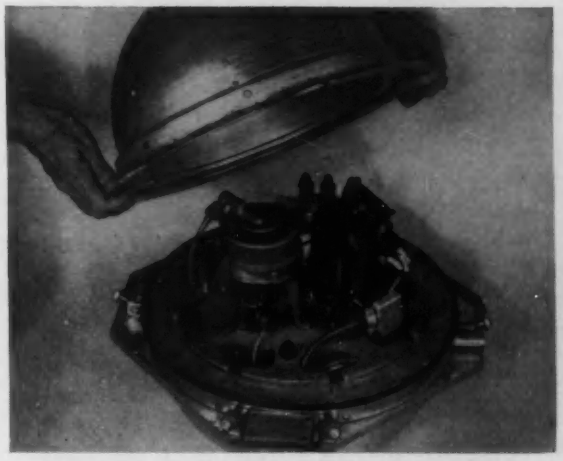
THE NEWS IN PICTURES



MEASURING 21 FT 8½ IN. IN DIAMETER, these biggest heads ever spun are going to be used just once—to test the penstocks for the hydro-electric development of the Connecticut River Power Company. Of 1¼ in. steel, four of these heads were spun on Lukens Steel Company's 276-in. flanging machine. The size created a shipping problem which was overcome by flame-cutting them in half after they were completed, and reassembling them at the destination.

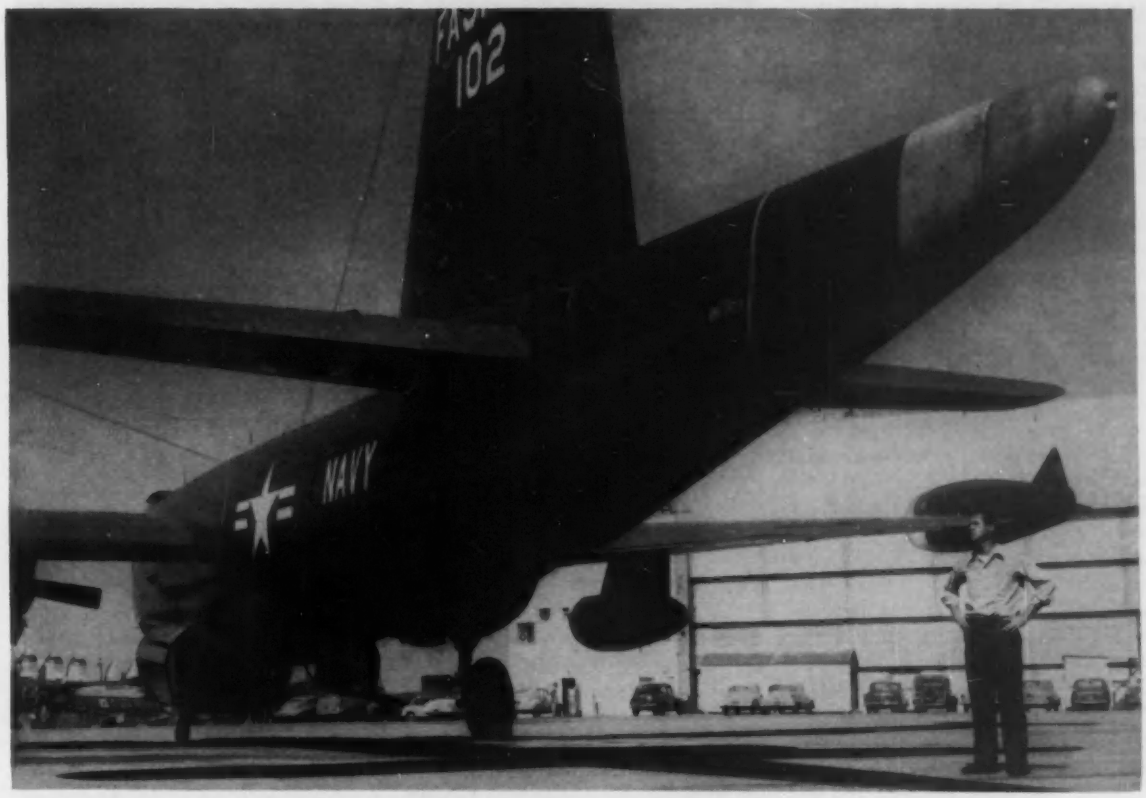


STRUCTURAL ENGINEER at North American Aviation checks one of the company's new reusable vacuum-held tension pads for proof-loading experimental aircraft. They are used in place of the old glue-adhered pads which required 24 hours to cure. Components consist of a non-porous layer separated from the test surface by a porous sheet, such as burlap, to form the air chamber from which a vacuum is created. Edges of the non-porous layer extend over the burlap and are sealed with tape. To the other side of the non-porous layer is attached sponge rubber, to which is attached load distribution plates. Adaptable to any contour, loads up to 14 psi can be held by these pads. Money savings are possible with the pad's quick application and removal, and a minimum of clean-up afterwards.



READY FOR USE in this crash-proof flight recorder which will contain essential flight data in a form that will withstand 2,000 F fire and 100 G shock. Made by the Mechanical Div. of General Mills, Inc., the instrument contains no electronic tubes, and will run for at least 15 minutes after power failure in the plane. It records heading, air speed, vertical acceleration, altitude, and time accurately on a strip of aluminum foil. Installation is simple with no separate remote indicators needed. It has been tested recently by the CAA.

AN ENGINEER at Bell Telephone Labs uses a dry box to assemble the new 440 million cycle, ultra-high-frequency transistor. Called an "intrinsic barrier" transistor, it can operate at low power, but, unlike earlier transistors it can also operate at relatively high power, perhaps up to ½ watt. It can also take as much as 100 volts. Besides increasing an electrical signal a thousand times, it may be used to generate electrical oscillations. Television sets, portable radios, and the transcontinental radio relay system are a few of the many possible uses.



THE ELONGATED TAIL ON THE NAVY'S NEPTUNE P2V-7 contains special equipment for submarine hunting. Built by Lockheed Aircraft Corp., the plane is known as the "Mad-Bird,,' with the M-A-D standing for Magnetic Airborne Detector. Not to be confused with radar, the device does its aerial detecting by registering disturbances in the earth's magnetic field. Combination of power plants shows at left one of the two turbo-compound engines; at right center one of the two jet engines for bursts of speed.

TECHNICAL NEWS

News Briefs

The Atomic Energy Commission has approved a plan by the Shipbuilding Div. of Bethlehem Steel Co. to study the application of nuclear power to commercial ship propulsion. This study is the second in the field of ship propulsion, and will include investigation of reactor types, steam cycles, control methods, machinery arrangements, and weight. The company will also study the development of a package reactor plant for small land-based electric power stations, or for distillation plants to provide fresh water in remote regions.

Completely formulated, ready-to-use powders, that produce low density silicone foam structures have been prepared by Dow Corning Corporation. Containing pre-measured proportions of resins filler blowing agent, and catalyst, the mixes melt, foam, and cure by themselves when heated. No further mixing or processing is required. Heat-stable and nonflammable, these materials can be cast in sheets or blocks of foam. Density can be controlled from 8 to 18 lb/cu/ft by varying the expansion temperatures. They remain stable up to 700 F, and have good physical an electrical properties.

Secret of Sonotone Corp.'s new nickel-cadmium battery is the sintered plates made of carbonyl nickel powder particles measuring from 30 to 6 microns. Fine mesh, pure nickel wire helps to hold the powdered nickel in place. The plates, which are made by the Amplex Div. of Chrysler, have an 80 per cent porosity. One battery consists of 15 of these plates, each impregnated with nickel and cadmium active ingredients, and ranging in thickness from 0.026 to 0.085 inch. The positive and negative plates are separated by layers of plastic and fabric. The battery will operate in temperatures up to 165 F and as low as −65 F.

An integrally stiffened aircraft skin, said to be the widest ever extruded flat, has been produced at the Lafayette works of the Aluminum Co. of America. The press extruded the 23-inch wide section in 75S alloy, and Alcoa announced that sections up to 34 in. wide can be furnished.

Calculator Gets Transistorized

"**This is merely one** of the many experimental projects on which our engineers are working, and it is one more step toward the computers and data processing machines of the future," said Mr. W. W. McDowell, V. P. in charge of research and engineering at IBM.

The occasion for Mr. McDowell's remark was the demonstration of IBM's new completely transistorized calculator, with a computing unit about one-half the size and requiring only 5 percent as much power as a comparable vacuum tube unit.

More than 2,200 transistors are used in the new calculator. Printed wiring is also used to replace much of the conventional wiring methods, and reduce space requirements. The calculator contains 595 printed wiring panels on which the transistors are mounted. Each panel, shown in the rack above, is about two-thirds the size of an IBM card.

The new machine is comparable in capacity but one-half the size of IBM's type 604 electronic calculator which uses 1,250 vacuum tubes. The new unit is regarded as the first transistorized computer complete with automatic input and output.

Arc-Melting Aids Search For New Alloys

In search of new methods of producing new alloys, scientists in General Electric's Research Lab. have designed a multi-purpose, inert-atmosphere, arc-melting furnace that is capable of handling materials usually considered too refractory for commercial production—chromium, niobium, tantalum, tungsten, titanium, and zirconium. Arc-melting research is one of the activities to be located in G.E.'s new metallurgy building, which is to be used for the development of new materials and processes. According to Dr. J. H. Hollomon, manager of the metallurgy department, "If we have reasonable success with the present experiments in arc-melting molybdenum, this process could develop into the most important method for handling

materials essential to jet engines, guided missiles, gas turbines and high temperature operation."

Attempts to melt molybdenum in a refractory crucible have resulted in reactions that include the container. These are detrimental to the final properties of the alloy. Molybdenum is important because it offers the possibility of increasing the operating range of present engines (1600 F) to 2500 F. Powder metallurgy has been partially successful, but can be used only in small quantities. With the arc-melting process, ingots of 1000 lb. or more can be made.

Dr. Hollomon also states that work work is now being carried on towards developing a technique whereby a titanium electrode can be fashioned continuously within the furnace itself. If this is successful, the expensive, time-consuming preparatory operations can be eliminated.

G.E.'s new arc furnace uses direct current and a non-consumable electrode. However, in the design stage is a new consumable electrode furnace capable of operation to 1/100,000,000th of an atmosphere, and at temperatures up to 12,000 F.

DESIGNERS OF THE NEW ARC-MELTING FURNACE examine a 50-pound ingot of molybdenum and another of titanium. Both ingots were melted at G.E.'s research laboratory in experiments with a prototype of the new multi-purpose furnace.

Higher Horsepower: Safety Factor or Killer?

Each year for the past few years, you could almost predict the slant of the new car advertising. High horsepower is always a good come-on, and if a salesman had a good prospect who was a bit undecided, chances are that by stressing the engine with 200-plus horsepower, it would be a good bet to clinch the sale. This does not mean, of course, that every driver approves of the powerful engines in present day cars. In fact, a large majority of them, if asked for their opinions on the subject, would probably say, "Where can I use that much power?"

Many people amplify these remarks by pointing to the large number of traffic fatalities–about 38,000 annually in recent years–and immediately tag high horsepower as the guilty party. "Why," they say, "don't the automobile manufacturers make their cars safer instead of increasing the horsepower each year?"

There is no denying that the horsepower has climbed. In 1918, the average horsepower of cars built in this country was 20. In 1930 it was up to 75. In 1942 the average was 115, and in 1953 it was up to 137 hp. This year it is 161 hp, and rough estimates place 1955's average around 188 hp. Helping this along will be Cadillac's 270 hp. Eldorado, Chrysler's 250 hp. (see p. 194), and Packard's new V-8, which has been tested to 272 hp., but which will probably be advertised as 265 hp.

Automobile engineers, though, consider high horsepower an added safety factor. Chrysler engineers, for example, compared a 1953 New Yorker (180 hp.) with the 1954 model (235 hp.), and found that with the latter, the time necessary to pass a 45 ft. truck going 50 m.p.h. was reduced from 7.2 sec. to 5.9 sec., a gain of 18 percent. The time accelerating from 40 to 80 m.p.h. was cut from 20.7 sec. to 13.7 sec., saving of 34 percent.

Now this does not mean that any engineer considers 80 m.p.h a safe and sane speed. They only say that it cuts down the time spent on the wrong side of the road, and gives an added measure of safety to the drivers who get caught out of line.

Higher horsepower causes more fatalities? The statistics say no. Two of the highest fatality years on record are 1941 (39,969 deaths) and 1937 (39,643), both when horsepower was much lower than it is now. Furthermore, you have to consider other factors. One, is the increase in the number of cars on the road. In 1918 there were 6-million cars, trucks, and buses on U.S. roads. By 1930 there were 26.5-million, and in 1953 this was increased to 55-million. It figures that fatalities should increase proportionately in this period–but they did not.

Horsepower went up 83 percent between 1930 and 1953, and the number of vehicles on the road increased about 106 percent. But fatalities from 1930 to 1952 increased 15 percent.

Another way to look at it is the to-

tal traffic deaths per 100-million vehicle miles. In 1927, the first year when these figures were available, the rate was 16.3 persons killed for every 100-million miles traveled. In 1930 it had dropped to 16.0. By 1952, the rate was down to 7.3, and in 1953 it fell to a record low of 7.0 deaths per 100-million miles.

From the standpoint of the death rate per 10,000 vehicles, in 1930 it was 12.4. The peak was reached in 1934 with 14.4. But in 1952 it was 7.2, just half of the rate 20 years ago.

The manufacturers know that even if they were to reduce the horsepower, it still would not put a check on the speed. Any hot-rodder or mechanic, by making a few alterations, can get high speeds out of a standard car having a 75 hp. engine. Furthermore, the low-powered foreign sports car can hit speeds in excess of many of the U. S. standard makes. The 70-hp. Porsche, for example, can get up to, and over 100-m.p.h. without any trouble at all.

Looking at it from the horsepower angle then, there is no sign that ratings will drop off. From the sales angle, a powerful engine is very helpful. Also, the engineer will always back high horsepower. Predictions from Detroit indicate 300-hp. for many cars in a few years.

The efforts to make cars safer than before still continue, with the manufacturers testing every possible new device and making crash studies as they have for years. Within practical limitations, all automobile manufacturers are biulding safety features into their cars. As one engineer put it, "We are building cars as safe as we can right now, at the price people can afford to pay. If we built one along the lines of a 'battleship', or an 'armored truck', the price would go up $600 or $700."

Car manufacturers feel that if there is to be more safety in automobiles, it will have to come from a more intensive driver education campaign. It is impossible to build a fool-proof car. For even in the safest of cars, it is the human error that causes the accidents and deaths. Statistics published by the National Safety Council show that drivers themselves are the cause of more than 90 percent of automobile accidents. Only six percent of the vehicles involved in fatal accidents had unsafe mechanical equipment—most of it from poor maintenance.

Coming Events

DEC. 8-10

Fourth Annual Eastern Joint Computer Conference and Exhibition, Bellevue-Stratford Hotel, Philadelphia, Pa. "The Design and Application of Small Digital Computers" will be the theme of this conference, which is being jointly sponsored by the AIEE, the IRE, and the Association for Computing Machinery. The latest products of over 60 companies in the computer field will be exhibited, and 21 papers have been received. The program includes papers on: computer comparisons; input-output devices; computer systems and characteristics, mathematics, programming; and business and scientific applications. Inspection trips to the Bell System automatic message accounting center; the Burroughs Research Center; the Franklin Institute network calculator; and Remington-Rand's Eckert-Manchly Div. have been planned. Information on registration from: Eastern Joint Computer Conference, P. O. Box 7825, Philadelphia, Pa.

JAN. 24-26

Plant Maintenance and Engineering Conference, International Amphitheatre, Chicago, Ill. The conference, one of the largest industrial meetings, is held concurrently with the four-day Plant Maintenance and Engineering Show. General sessions of the conference will be held in the mornings in the arena of the Amphitheatre. The smaller sectional conferences and round-tables will be held in the evenings. Afternoons will be held free for exhibits. Separate round-table sessions will be set up for each of five industries: chemical; food; paper; steel; and textiles. One sectional conference will be devoted to the process industries. Advance registration from Clapp & Poliak, Inc., 341 Madison Ave., N. Y. 17, N. Y.

JAN. 24-28

12th International Heating and Ventilating Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa. It will coincide with the 61st Annual Meeting of its sponsor, the American Society of Heating and Ventilating Engineers. Among the "firsts" displayed will be a newly developed positive humidifier for warm air heat. In the field of air movement, there will be a primary exhibit of flexible tubing for branch ducting in both high and low pressure air conditioning systems.

JAN. 31-FEB. 4, 1955

AIEE Winter Meeting, Statler Hotel, New York. Because of the number of sessions, the symposiums and sessions will be held at both the Statler and the Governor Clinton Hotels. Besides the technical sessions a program of entertainment and inspection trips is planned. The registration of 5,000 at last year's show is expected to be exceeded.

JAN. 31-FEB. 11, 1955

Engineering and Management Course, Univ. of California, Los Angeles. A two week course for executives, supervisors, engineers, industrial analysts, cost accountants, and other line and staff personnel. Each student selects his program, in subjects ranging from production management, time and motion study, quality control to mathematical programming, electronic data processing, and automation. The fee of $300 includes the cost of text and course materials, ten luncheons, and three dinners. For further information write to: Edward P. Coleman, Engineering and Management Course, College of Engineering, Univ. of Cal., Los Angeles 24, Calif.

FEB. 8-10, 1955

The 10th Conference of the Society of the Plastics Industry Reinforced Plastics Division, Hotel Statler, Los Angeles, California. Under the direction of Richard H. Malamphy of the Naugatuck Chemical Div., the conference is being planned around the theme: "The Industrial Progress in Reinforced Plastics in Important End-Use Areas." Tentatively, the committee plans to highlight the subjects of: transportation, including aircraft; tooling; automobiles; boats; trucks; reinforced plastics in the construction field, including panels both flat and corrugated; containers and machine housings; and corrosion resistant applications, such as pipe, tanks, ducting, and others.

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HOW TO CHOOSE A

SMALL LIGHT RELAY...

from the Automatic Electric line

When there's one *best* miniature relay for a given job, be sure you get it! Select the proper Automatic Electric relay and get peak performance, lower costs.

Painstaking workmanship, rigid quality controls and advanced design features have produced a wide range of performance...fast...sensitive...rugged...with a dependability that meets the stresses and strains of the world's toughest applications. The great demand for these relays makes careful planning worth your while to assure required delivery of the particular relays you need!

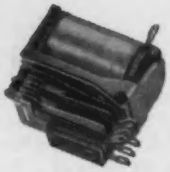
Complete facts and figures on Automatic Electric's Relay line are yours upon request—ask for Circular 1702. Write Automatic Electric Sales Corporation, 1033 W. Van Buren St., Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS SWITCHES

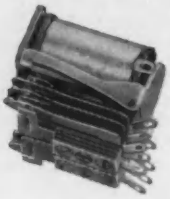
PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

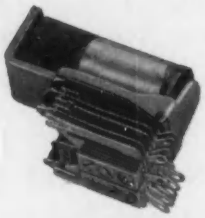
CHICAGO



WHEN SIZE AND WEIGHT ARE LIMITING FACTORS...
Choose this smallest of all Automatic Electric miniature relays. Capacity: 6 contact springs. Weight: 1¼ oz. Dimensions: 1 11/16" x 1 5/16" x 11/16". *Specify: Series SQA Relay.*



WHEN GREATER CONTACT SPRING CAPACITY IS REQUIRED...
Choose this double pile-up relay—larger spring capacity in miniature. Capacity: 12 contact springs (up to 18 in some cases, depending upon operating requirements). Weight: 1½-2 ozs. Dims.: 1 11/16" x 1 5/16" x 1". *Specify: Series SQD Relay.*



WHEN ADDITIONAL COIL VOLUME IS IMPORTANT...
Choose this relay which accommodates a slug or sleeve for longer release and/or operate time; a second winding for holding, knock down, or separate operation; or greater winding volume for increased sensitivity or greater heat dissipating ability. Capacity: 12-18 contact springs. Weight: 2-4 oz. Dimensions: 2 1/16" x 1 5/16" x 1". *Specify: Series SLQ Relay.*

FOR EXTRA SENSITIVITY
The "sensitivity" of a Class "S" Relay can be doubled through the use of oversized coils (1/16" larger diameter than standard coils). For example: under favorable conditions, standard size coils permit operation of 1 Form "C" spring combination at 4 milliamperes, 24 volts dc; similarly oversized coils permit operation at 2 milliamperes, or less.

HERMETICALLY SEALED—SPECIAL MOUNTINGS
Class "S" Relays are available with or without plug mountings. A wide variety of hermetically sealed enclosures are offered for protection of single or multiple relays.

Equations for Determining Angles for Machining

M. F. SPOTTS
Northwestern Technological Institute

IT IS SOMETIMES NECESSARY to machine a body containing a plane surface inclined at an arbitrary angle in space. Trial and error is usually used to orient the surface parallel to the table of the milling machine or planer. This process is time consuming and may be lacking in accuracy.

Since three points serve to locate a plane, let the surface under consideration be given by P_1 P_2 P_3 in Fig. 1. In addition let the body be so shaped that no over-run of the cutting tool can take place across P_1 P_3. In the final position this line, P_1 P_3, must be parallel to the ways of the machine.

Fig. 2 shows the body of Fig. 1 mounted on an adjustable angle plate located on the table of the machine tool. The angle plate is located at angle φ with the ways. Inclination of the angle plate is given by θ. Line O_1 O_3, the projection of P_1 P_3, is at angle ψ with a normal to the hinge of the angle plate. Proper values for the three angles φ, θ, and ψ will bring surface P_1 P_2 P_3 into the horizontal, and line P_1 P_3 parallel to the ways.

Figure 3 shows surface P_1 P_2 P_3 in an X, Y and Z coordinate system. By placing P_1 in the XY plane, P_2 in the YZ plane, P_3 in the ZX plane and taking $x_1 = x_3$, some of the coordinates are zero and the equations for the angles φ, θ, and ψ are simplified. Values for the coordinates for P_1, P_2 and P_3 in Fig. 3 can be determined from the dimensions of the body.

The equations for the angles are:

$$\tan \Psi = \frac{y_1(z_2 - z_3) + y_2 z_2}{Z_3 x_3} \qquad (1)$$

$$\tan \theta = \frac{z_3}{y_1 \cos \Psi} \qquad (2)$$

$$\tan \varphi = \frac{y_1 \cos \theta \cos \Psi + Z_3 \sin \theta}{y_1 \sin \Psi} \qquad (3)$$

EXAMPLE. Let the coordinates be P_1 (4.32, 7.78, 0), P_2 (0, 1.97, 3.36), and P_3 (4.32, 0, 1.65).

SOLUTION. Substitution in Eq (1) gives

$$\tan \Psi = \frac{7.78\,(3.36 - 1.65) + 1.97 \times 1.65}{1.65 \times 4.32} = 2.322433$$

$$\Psi = 66.7041 \text{ deg}$$
$$\sin \Psi = 0.9184748$$
$$\cos \Psi = 0.3954798$$

Substitution in Eq (2) gives

$$\tan \theta = \frac{1.65}{7.78 \times 0.3954798} = 0.5362657$$

$$\theta = 28.2031 \text{ deg}$$
$$\sin \theta = 0.4725984$$
$$\cos \theta = 0.8812776$$

Substitution in Eq (3) gives

$$\tan \varphi = \frac{7.78 \times 0.8812776 \times 0.3954798 + 1.65 \times 0.4725984}{7.78 \times 0.9184748}$$

$$= 0.4885896$$
$$\varphi = 25.0397 \text{ deg}$$

Algebraic signs must be observed in utilizing the results from the equations. A plus result requires a counterclockwise rotation and a minus result indicates a clockwise rotation. The angle plate is first placed on the table with the hinge or axis parallel to the ways. The body is first placed on the angle plate with O_1 O_3 perpendicular to the hinge. The positive directions for the coordinate axes X, Y and Z are as illustrated in Fig. 2. A positive angle φ is then a CCW rotation of the angle plate when looking towards the origin from Z. A positive angle θ is given by a CCW rotation about the hinge of the angle plate when looking from X_1 towards the origin. A positive angle ψ consists of a CCW rotation of the body on the surface of the angle plate about the normal O_3 Z_3.

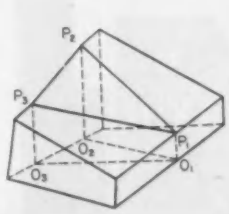


Fig. 1

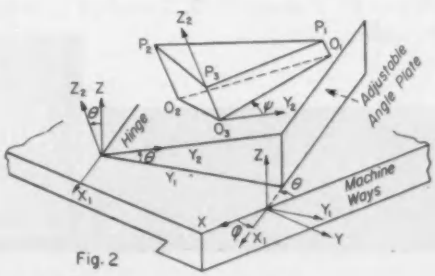


Fig. 2

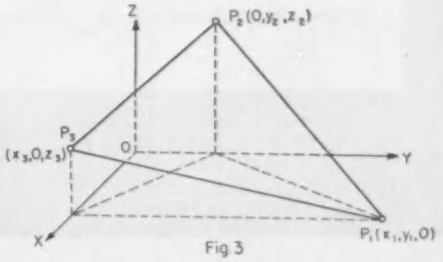
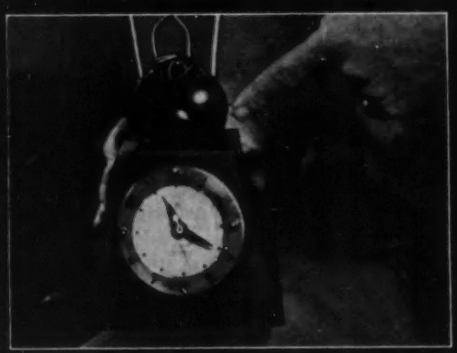


Fig. 3

THE DESIGNER AND ENGINEER:
pioneers of improved products for company growth

Interior antenna is inspected. Bases of Lustrex Hi-Test 88 styrene plastic are molded in halves. A pole is then inserted in each half, connections are secured, and one master bolt completes fast, easy assembly.



"Vee Ball" base (Above) and "Clock-tenna" (Below) are molded by Leaf Molding Company, who also supply RMS with insulators for outside antennae, made of Lustrex styrene.

After other materials fail, RMS designers solve TV antenna problem with

HI-TEST 88 MONSANTO LUSTREX Styrene Plastic

Seeking the best possible material for bases and insulators to be used on their inside and outside aerials, Radio Merchandise Sales, Inc., set up these rigid requirements: excellent insulating properties; unusual tensile strength; superior impact resistance; weatherability and water-resistance; design flexibility; wide color range; adaptability to mass production; low unit cost; elasticity; and impressive sales appeal. Other materials failed to meet this combination of "musts." *Only Lustrex Hi-Test 88 styrene plastic passed all tests with flying colors.*

This successful application typifies the results designers and production men are obtaining with Lustrex Hi-Test 88 styrene. It dramatizes, too, the many new applications possible with a material having such a range of outstanding characteristics. Perhaps Lustrex, or another of Monsanto's family of plastics, can help solve your design and production problems. For information write to MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2113, Springfield 2, Mass.

Meet more Monsanto products on the CBS-TV "Morning Show"

MONSANTO

SERVING INDUSTRY . . . WHICH SERVES MANKIND

Formula for Epicyclic Gear Train Of Large Reduction

M. F. SPOTTS
Northwestern Technological Institute

WHEN LARGE SPEED REDUCTIONS are required, the epicyclic train shown in Fig. 1 can be effectively employed. Input shaft *A* is keyed to gear 1 which turns gear 2 as well as the right side of the case through gear 3. Output shaft *B* is attached to the arm that carries gear 5 which in turn meshes with gear 4 and with the case at gear 6.

Fig. 2 shows a front view of the gears. Radius OC of gear 3 was originally vertical but has been rotated to the position shown. In so doing arcs *CD*, DE, FG and GH are all equal to each other. If the rotation of shaft A is denoted by θ_a then angle *COD*, turned by gear 3, is $(N_1/N_3)\ \theta_a$, where N_1 is number of teeth in gear 1 and N_3 is number of teeth in gear 3. Arc *GH* subtends angle $(N_1/N_3)\ \theta_a$.

Starting points C and *J* for gears 3 and 6 were originally vertical. Terminal points *H* and *P* for gears 2 and 4 were also originally in the vertical. Rotation θ_b of the arm must therefore be an amount sufficient to make arcs *JK*, *KL*, *MN* and *NP* equal to each other.

If θ_c represents the rotation of gear 5, then the angle subtended by arc *NP* is equal to $(N_5/N_4)\ \theta_c$. Arc JK subtends angle $(N_6/N_6)\ \theta_c$.

The following equation can now be written:

$$\angle\ COH = \left(\frac{N_5}{N_6} + \frac{N_5}{N_4}\right)\theta_c = \left(\frac{N_1}{N_3} + \frac{N_1}{N_2}\right)\theta_a$$

or
$$N_1\left(\frac{N_4 + N_6}{N_4 N_6}\right)\theta_c = N_1\left(\frac{N_2 + N_3}{N_2 N_3}\right)\theta_a$$

then
$$\theta_c = \frac{N_1 N_4 N_6}{N_2 N_3 N_5}\left(\frac{N_2 + N_3}{N_4 + N_6}\right)\theta_a \qquad (1)$$

Rotation θ_b of the arm as well as the shaft B is equal to

$$\theta_b = \frac{N_1}{N_3}\,\theta_a - \frac{N_5}{N_6}\,\theta_c$$

when the value of θ_c from Eq (1) is substituted, the result can be reduced to

$$\frac{\theta_b}{\theta_a} = \frac{N_1(N_2 N_6 - N_3 N_4)}{N_2 N_3(N_4 + N_6)} \qquad (2)$$

EXAMPLE. Find the velocity ratio for the train if $N_1 = 12$, $N_2 = 51$, $N_3 = 76$, $N_4 = 49$, $N_5 = 12$, and $N_6 = 73$.

Solution. Substitution in Eq (2) gives

$$\frac{\theta_b}{\theta_a} = \frac{12(51 \times 73 - 76 \times 49)}{51 \times 76(49 + 73)} = -\frac{1}{39{,}406}$$

An arrangement of gears like Fig. 1 is thus capable of giving very large reductions. It should be noted that these values for the numbers of teeth require non-standard pitch circle radii and non-standard thicknesses of teeth for gears 1, 2, and 3. Computations for these can be made as explained in *Product Engineering*, May 1945, p. 339.

If gear 2 in the above example has 52 teeth, all gears will have standard proportions, but the ratio is then reduced to 1/558.04.

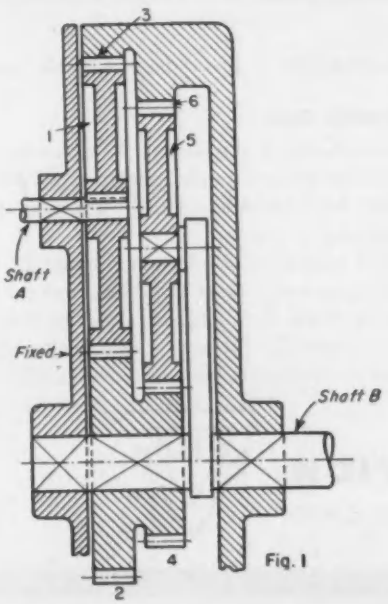


Fig. 1

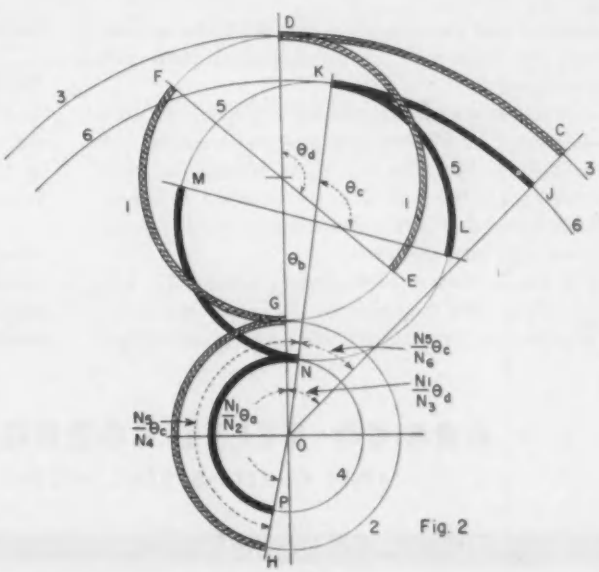


Fig. 2

Here's workable stainless that's safe at 130,000 psi stress

This stainless steel pressure vessel operates under an average stress of 130,000 psi . . . is tested at a calculated stress of 169,000 psi.

Of course, the shell is constructed of a special stainless steel — Armco 17-7 PH — a precipitation-hardening type made only by Armco. The two halves are readily drawn and welded while the steel is in the annealed condition. The finished assembly is then hardened by double precipitation-hardening heat treatment.

This is the procedure for hardening Armco 17-7 PH. It is first held at 1400 degrees F for 1½ hours, then cooled to 60 degrees F or lower. After that comes a second heat treatment at 950-1050 F for ½-hour and air cooling.

WELDS STRONG TOO

The result of this double heat treatment is a minimum yield strength of 150,000 psi and tensile strength of 180,000 psi or higher. Welds have this same strength when made by the inert-gas shielded-arc system.

If you need a stainless steel with easy workability, high strength, endurance and fatigue resistance, write for information on the Armco Precipitation-Hardening Stainless Steels. Besides Armco 17-7 PH there is the single heat treatment precipitation-hardening bar grade, Armco 17-4 PH.

ARMCO STEEL CORPORATION

4944 CURTIS STREET, MIDDLETOWN, OHIO

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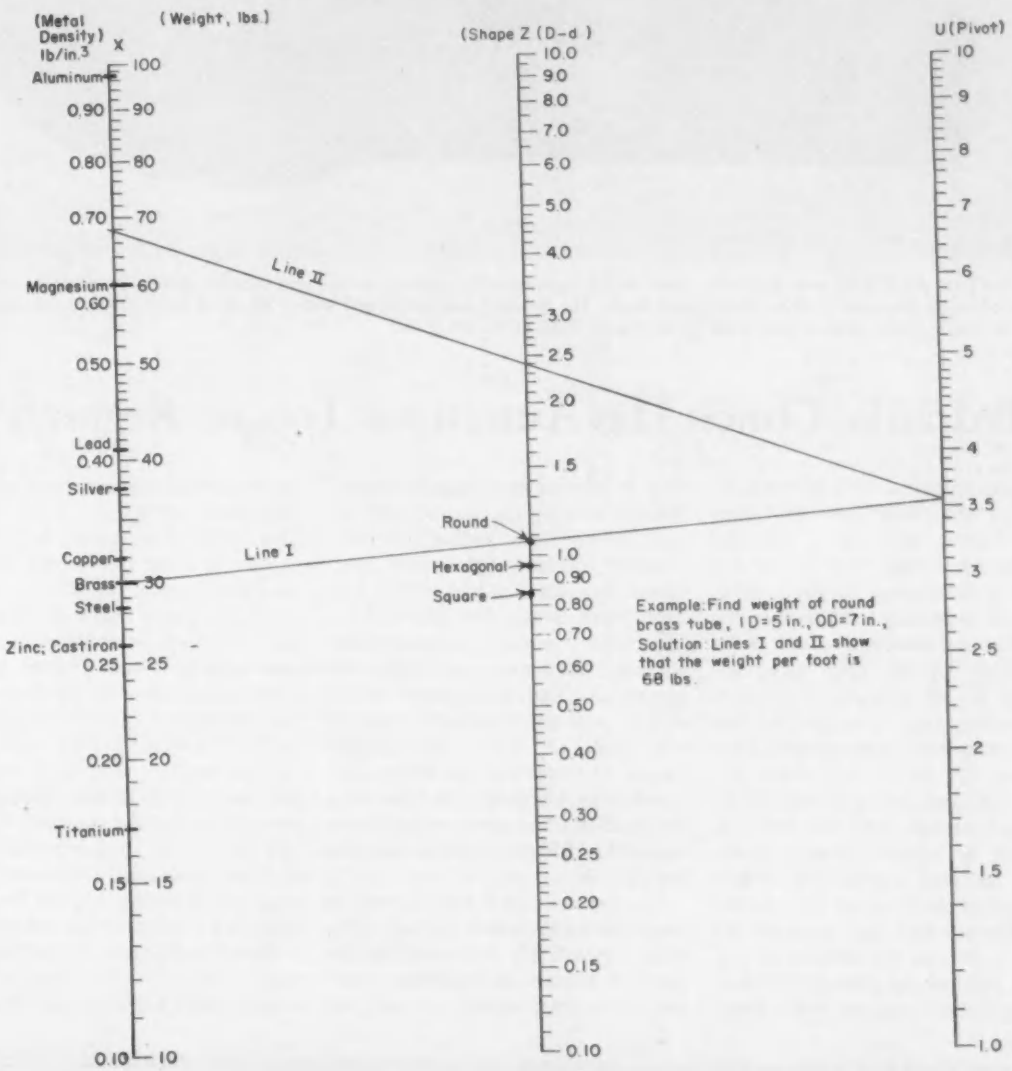
Nomograph for Weights of Tubes

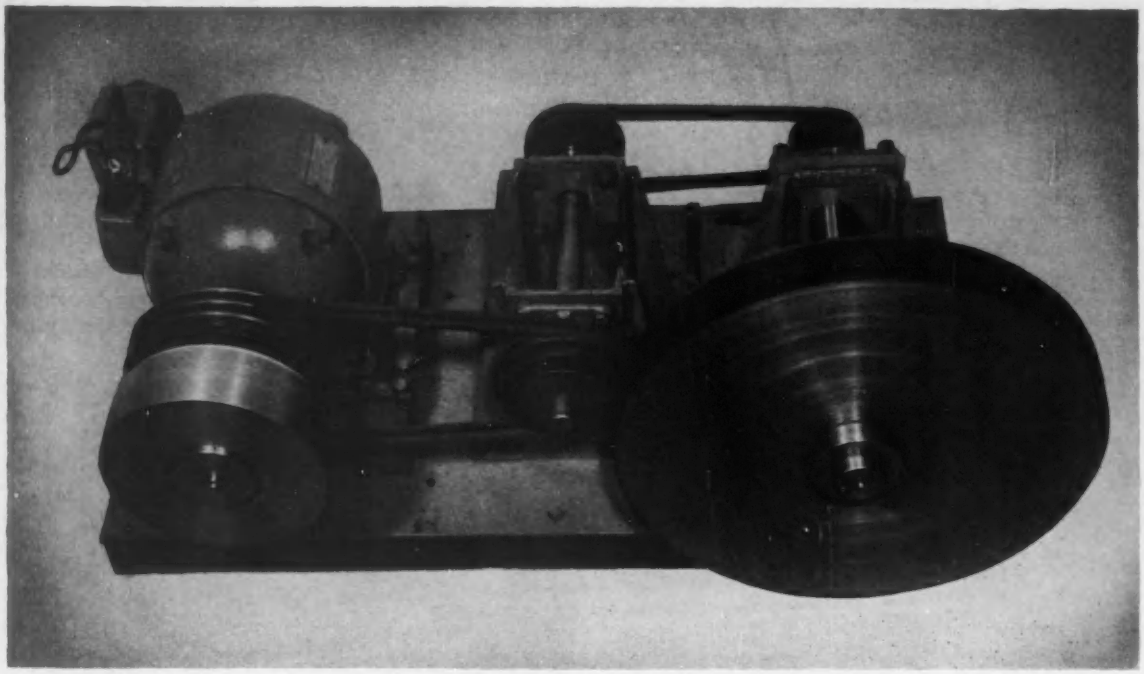
CARL NACHOD
Vice President, Nachod & U. S. Signal Co., Inc.,
Louisville, Kentucky

THIS CHART gives the weight per foot of ten metals and three different shapes, round, hexagonal and square. Also, it will show the weights of solid rods by substituting D^2 for D^2-d^2, and the weight of the length of any tube by drawing from the weight per foot on scale X to the required length in feet on scale U.

The locations on scale Z for round, hexagonal and square tubes are: 1.062, 0.96 and 0.833, respectively. Other metals than those shown on X may, of course, be added, at their proper density values.

The density of magnesium and aluminum on scale X are ten times their true values. Thus, the weight obtained from the chart must be divided by ten to get the correct value for these two light metals.





TEST INSTALLATION of new hydraulic clutch which automatically controls torque and current making it possible to reduce the size of motor required to drive high inertia loads. The flywheel weighs 292 and with a 2:1 speed ratio, runs at 3,300 rpm. Corrected to motor speed, this is equivalent to an inertia load of 86,400 lb-in.^{2}

Hydraulic Clutch Has Automatic Torque Regulation

When driving a high inertia load with an essentially constant speed prime mover such as a standard squirrel cage motor, the size of the motor is determined by the starting torque. Because they tend to offset this condition and therefore reduce motor size, fluid clutches offer many advantages in such applications. (*Product Engineering*, Aug. 1954, pp 174-178).

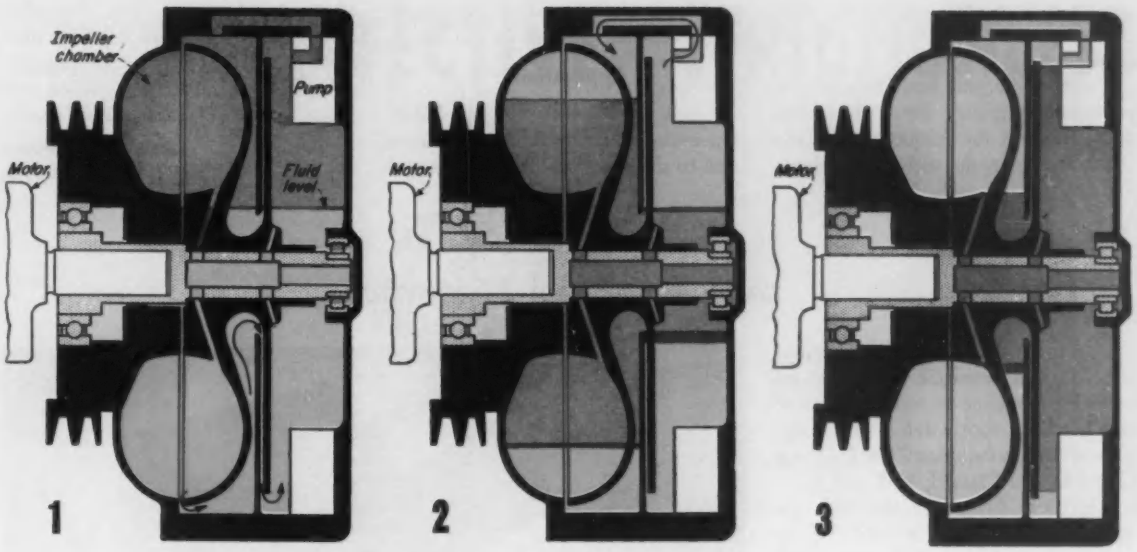
However, with conventional fluid clutches, the motor still draws between 400 and 600 per cent of its full load current until the load approaches its normal running speed. When the load inertia is of such a magnitude that this takes 3 to 4 minutes, the overload will burn out or seriously damage the motor.

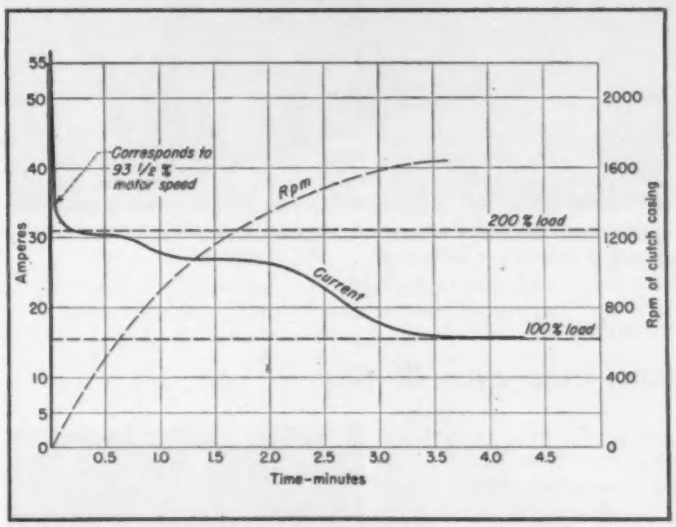
One solution to such problems is to control the filling rate of the coupling by manual or electronic means—thereby keeping the torque and current values from getting excessive. Another solution—with several additional advantages—is now offered by a new clutch design that accomplishes the same purpose automatically—without additional equipment or operators. The photograph above shows a typical test installation; on the next page are typical performance curves. Although the load inertia, corrected to motor speed, was more than 86,000 lb-in.^{2}, the motor current drops to less than 200 per cent full-load in a few seconds.

The operation of this new clutch is illustrated on the following page. The oil is automatically removed from the impeller chamber during starting conditions by the relative motion between the impeller and housing. This effectively disconnects most of the load, allowing the motor to come up to speed in about two seconds (see note on current curve, pg 217). At this point, the pump begins to return the oil to the impeller chamber at such a rate that the motor current is held practically constant at any desired preset value between about one-and-a-half and two times the full load value.

Now available only in 5 hp size, this new clutch design is being extended to include capacities up to 100 hp. It is no larger than conventional couplings of the same rated capacity and can be supplied for either motor-shaft mounting or direct drive.

Running slip is 3 per cent or less, which compares very favorably with conventional couplings operating with





TYPICAL PERFORMANCE CURVES obtained with test unit on page 216. With the same load, a conventional, fixed-volume fluid coupling of the same rated capacity draws 400 to 600 per cent full-load current for several minutes.

1 STARTING . . . oil level is approximately as shown when clutch is stationary. As motor speeds up oil is removed from the impeller chamber (see arrows).

2 TRANSITION . . . as motor speed approaches its normal running value, the pump returns oil from the outer casing to the impeller chamber (see arrow). As shown in curves at the left, motor reaches 93 per cent running speed in about two seconds.

3 RUNNING . . . at normal running conditions, oil level in the clutch is approximately as shown. Speed slip is within 3 per cent at full load. In the event of a jam, oil is dumped from impeller chamber and motor can run indefinitely without damage.

complete filling. For large inertia loads, it is a common practice to make conventional units "soft" by underfilling. This introduces inefficiencies–and is definitely limited in terms of its effectiveness. For example, a typical conventional coupling with complete filling may have a normal speed slip of 3½ per cent. When the switch is closed at starting (output shaft at zero speed), the motor will accelerate to about 950 rpm, at which point the motor torque equals the stall torque of the coupling.

If the unit is only partially filled so that the motor speed with stalled output will be about 1,250, the running slip is almost doubled–or 6 per cent–and losses are thereby increased.

Another feature claimed for the new clutch is that of overload protection. It is available for a wide range of stall torque values–for example, 50, 100, 150 or 200 per cent of full load. Since stall torque is independent of running speed slip, it can run completely

CONTINUED ON PAGE 218

filled without introducing heating or energy dissipation problems. In the event of a complete jam, as may occur in a conveyor application, the motor can run indefinitely without damage.

Furthermore, one limitation of conventional couplings for high inertia applications is the frequency of starts that can be made without overheating. Under the test conditions of Fig. 1, the new clutch has repeatedly been started four and more times per hour. After four starts, the motor casing was barely warm to the touch.

Applications

When used with a 5 hp induction motor, this new clutch has been used to drive inertia loads that would otherwise require an 11 hp motor of the same type—directly connected to the load. Some of the many areas where this economy, plus the other advantages cited above offer promise involve conveyor drives, pumps, centrifugals, machine tools, hoists and cranes. Tri-Kris Co., Inc., Lansdale, Pa.

For more information—
Circle 1, inside back cover

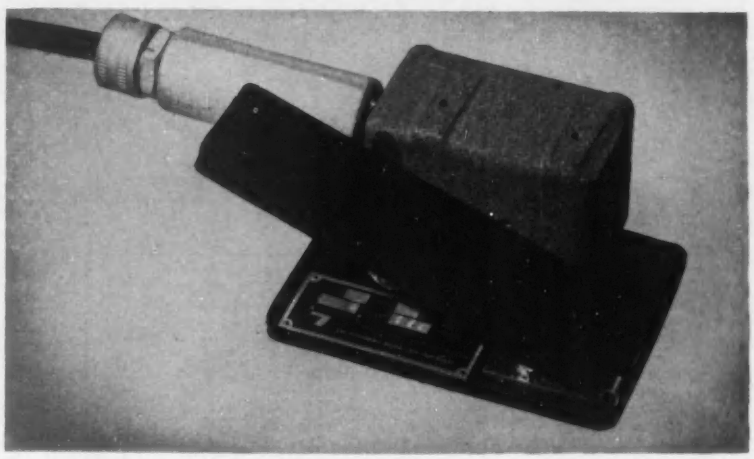
Explosion-Proof Footswitch

For use in those areas where industrial and scientific processes involve the presence of explosive fumes, the Model 3 footswitch uses UL-approved components for Class I, Group C and D and Class II, E, F and G.

Electrical ratings of the unit for ac are up to 15 amp at 125, 250 or 460 v. D-c ratings are ½ amp at 25 v, ¼ amp at 250 v. Contacts can be connected for either normally-open or normally-closed operation.

The new switch is of grounded construction, and is supplied in standard form with a 15-ft Type S cord and a three-prong male plug. Levinthal Electronic Products, Inc., 2981 Fair Oaks Ave., Redwood City, Calif.

For more information—
Circle 2, inside back cover



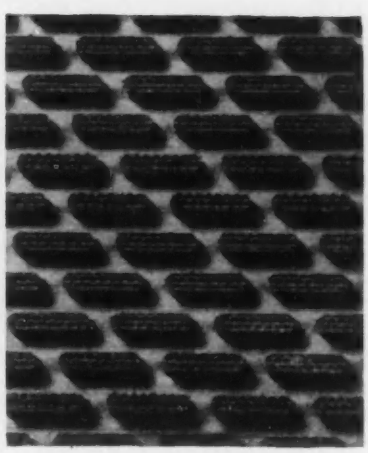
THIS FOOTSWITCH can be used in areas where Class I, Group C and D and Class II, Group E, F and G hazards are encountered.

Slip-Resistant Conveyor Belting

Paper board cartons, wooden cases, cellophane-wrapped articles and merchandise of many kinds are said to be carried up inclines as steep as 45 deg without "avalanching" by a new conveyor belt with a slip-resistant surface. The lift angle of the new belt is as much as 50 percent steeper than that of most conventional package belts. Rubber cleats covered with tiny grippers on the surface of the belt hold packages on steep descents. The belt is self-cleaning. As it flexes over pulleys, the cleats, which are arranged in staggered rows, spread apart, throwing out dirt and other foreign material. When used outdoors on portable conveyors, the design will allow rain water to run off easily.

Molded construction of the belt anchors the cleats strongly to the carcass and prevents them from being torn loose by heavy cases. One square foot of the cover contains approximately 960 cleats. The cleats are $\frac{5}{32}$-in. high, ½-in. wide and ⅛-in. long, and are spaced in diagonal rows ⅛ in. apart, both lengthwise and crosswise. The new belt is made in widths up to 48 in. United States Rubber Co., Rockefeller Center, New York 20, N. Y.

For more information—
Circle 3, inside back cover



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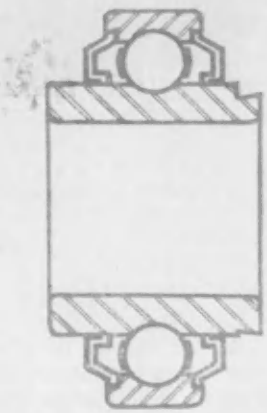
preference points on power transmission units

Seals that are

EFFECTIVE . . FRICTIONLESS

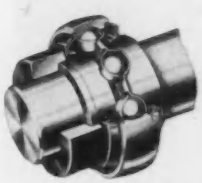


The Mechani-Seal consists of two "dished" steel plates. The inner member is fixed securely in the outer ring. The outer member is pressed on the outside diameter of the inner ring.

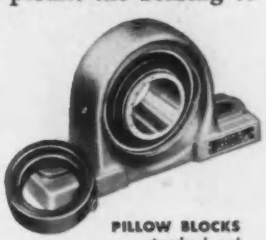
For applications where the bearing must be thoroughly protected against the entrance of foreign matter, or where grease must be absolutely retained within the bearing, the Fafnir Mechani-Seal Bearing offers definite advantages. This is the bearing you'll find in most Fafnir Ball Bearing Power Transmission Units.

The labyrinth design of the Fafnir-originated Mechani-Seal provides an inner trap seal for grease retention and an external rotating slinger for dirt exclusion. Close, but definite clearances between various seal members permit the bearing to "breathe". What's more, they insure it against drag, either in starting or running . . . no rubbing to introduce friction . . . no wear. Seals are integral with the bearing, are not subject to fouling or misalignment, and are corrosion and rust resistant.

When you compare design features, point for point, you can readily understand why the preference is for Fafnir Ball Bearing Power Transmission Units. For more details and a complete description of Fafnir Power Transmission Units call your Fafnir Representative. The Fafnir Bearing Company, New Britain, Conn.



WIDE INNER RING BALL BEARINGS
. . . with Mechani-Seals

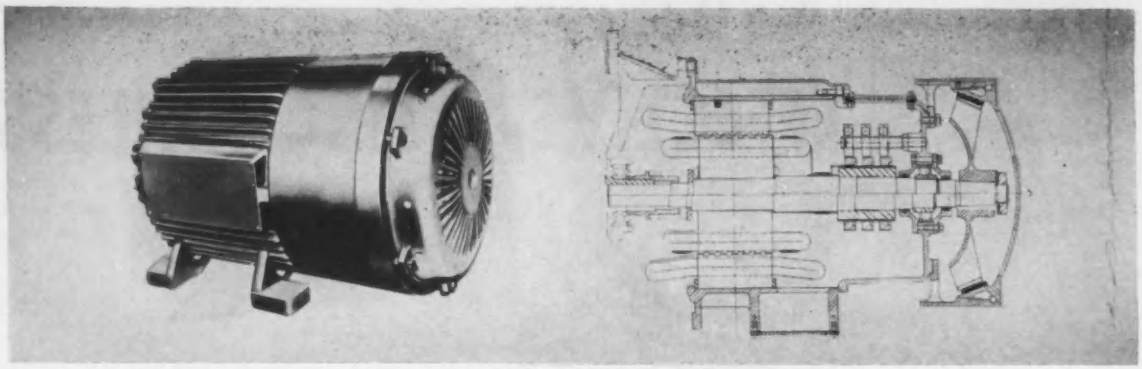


PILLOW BLOCKS
. . . standard and heavy series

FLANGE CARTRIDGES
. . . standard and heavy series

CYLINDRICAL CARTRIDGES
. . . standard and heavy series

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



WITH A BUILT-IN BRAKE, these motors resemble other totally enclosed, fan-cooled units and they meet all NEMA standards. Rotor is shown in stopped position in upper section of above drawing and in running position (below), with brake disengaged.

Thrust Brake Motors of ¾ to 30 Hp

Of both squirrel and slip ring design, these motors have a built-in brake. Axial thrust for braking action is provided by a coil spring. Counterthrust, which takes place as the motor is energized, is reported to be accomplished as the result of the flux-aligning tendency of the grooved rotor and stator design. In accompanying drawing, upper section illustrates rotor in stopped or "brake-set" position. Lower section shows rotor in running position, with brake disengaged.

These motors, which in outside appearance resemble other totally enclosed, fan-cooled motors, meet all NEMA standards. The rotating brake member also acts as an effective fan for air cooling of the motor. Brake release is stated to be fast. Harnischfeger Corp., 4607 W. National Ave., Milwaukee 46, Wis.

For more information—
Circle 4, inside back cover

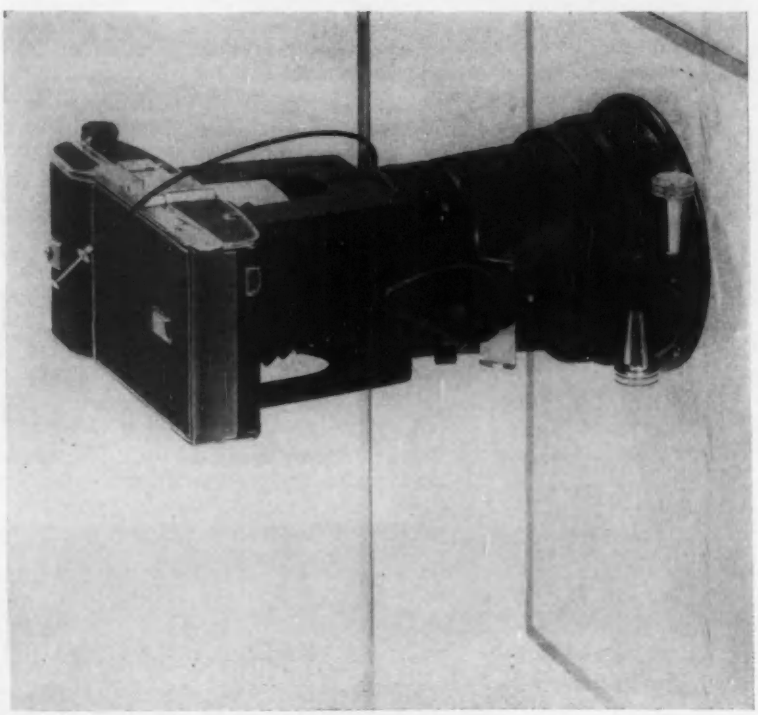
Camera for Oscilloscopes Provides Prints In 1 Min

This camera delivers a permanent photographically accurate record of single transients or identical repetitive phenomena that appear on an oscilloscope tube in the shortest possible time after they have occurred. It will record phenomena from a 5-in. cathode tube at a 1:1 ratio.

The unit is designed to mount on any scope type of electronic device having a 5-in. tube and a bezel measuring 5⅞ in. OD, by virtue of the constriction ring supplied as part of the camera assembly. It offers a single image per print.

Shutter speeds are 1 to 1/100 sec, time and bulb. Print area is 3 by 4 in. Fairchild Camera & Instrument Corp., Robbins Lane, Syosset, N. Y.

For more information—
Circle 5, inside back cover



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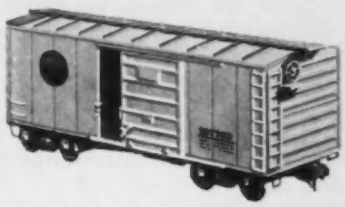
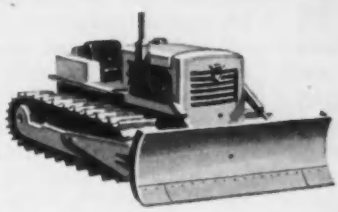
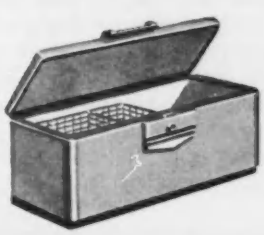






Make it WEIGH LESS and LAST LONGER with

N-A-X

HIGH-TENSILE STEEL

You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans.

- It is 50% stronger than mild steel.
- It is considerably more resistant to corrosion.
- It has greater paint adhesion with less undercoat corrosion.
- It has high fatigue life with great toughness.
- It has greater resistance to abrasion or wear.
- It is readily and easily welded by any process.
- It polishes to a high lustre at minimum cost.

And with all these physical advantages over mild carbon steel—it can be cold formed as readily into the most difficult shaped stamping.

When you next start to redesign, get the facts on N-A-X HIGH-TENSILE. It's produced by Great Lakes Steel—specialists in flat-rolled steel products for over 25 years.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Valve Has Interchangeable Parts

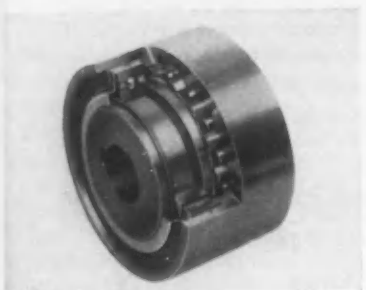
Hand lever, finger-tip or foot lever, piloted or cam roller actuator assemblies can be quickly and easily mounted on a new basic valve body due to simplified construction of the internal parts. This is said to make it possible for an inexperienced layman to combine or exchange actuating assemblies in the field, to change over from one valve type to another to meet specific valve requirements.

Such components also make it possible for a purchaser to secure quicker delivery on valves normally considered as "specials". Also, an entire series of valves can be kept available by stocking the basic valve and a selection of actuator assemblies.

Mounting brackets and actuators may be rotated 90, 180 or 270 deg for mounting and operating the valve in any position. All valve types are available in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. (modified) NPT ports for use with air, and in $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{3}{8}$ NPT ports for oil and water hydraulic systems. Beckett-Harcum Company, Wayne Road, Wilmington, Ohio

For more information—
Circle 6, inside back cover

MECHANICAL COMPONENTS



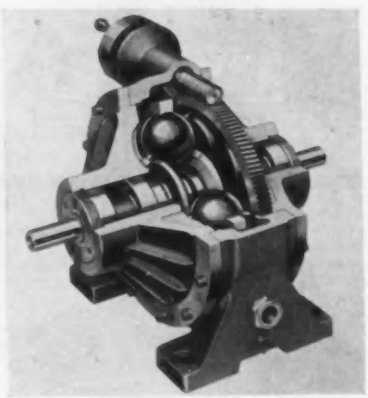
Cam Clutches For Indexing Applications

This line of self-contained units includes a single-row ball bearing that helps maintain concentricity of the inner and outer races. They are intended for application on stepped shafts in machinery drives. The customer supplies a ball bearing to support the opposite end of the unit, which has an outer race bore ground to fit the outside diameter of standard, single-row, snap-ring ball bearings. Typical applications for these versatile indexing clutches, which are also adaptable to general duty over-running and backstop operations include feed rolls, spring coilers, metal forming equipment, dual drives and two-speed applications.

These new clutches have constant pitch spacing, alternate cam and roller construction that provides accurate indexing operation. The clutch cams are a specially designed shape that avoids cam roll-over under peak or torsional loads. Low locking angles on the cam faces assure self-energizing action of each cam. An auxiliary energizing spring insures energizing under light loads and varying conditions.

Series HT clutches are made in three standard models with both standard and made-to-order keyway and setscrew bore sizes. Model HT-10 is rated at 15 ft-lb torque, indexing 30 ft-lb general duty and 42 ft-lb backstop. It has a normal overrunning drag of 2.4 in.-lb at 1,750 rpm and weighs about 2.6 lb. Model HT-20 is rated at 55 ft-lb torque, indexing; 110 ft-lb general duty and 154 ft-lb backstop. It has a normal overruning drag of 3.4 in.-lb at 1,750 rpm and weighs about 5 lb. Model HT-30 is rated at 160 ft-lb torque, indexing; 320 ft-lb general duty and 440 ft-lb backstop. It has an overruning drag of 4.0 in.-lb at 1,750 rpm and weighs about 11 lb. Morse Chain Co., 7601 Central Ave., Detroit 10, Mich.

For more information—
Circle 7, inside back cover



Variable Speed Drives

This variable drive is now available in nine sizes, ranging from $\frac{1}{4}$ to 10 hp at 1750 input rpm. Power is transmitted from the input shaft to the output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the two shafts are adjusted through a 9:1 range (from

CONTINUED ON PAGE 224

HERE'S PROOF: You can always count on Continental for every fastener need!

Only Continental Specializes in Special Fasteners

...to meet your every need

Continental has specialized the handling of special fastener orders to better solve your problems. They now turn out well over 5,000 different blueprints each week. Specialized engineers have been assigned to each phase of this fastener production to better concentrate their work and to save you time and money.

Each Continental engineer has had experience producing ground thread taps and gages, with their exacting screw thread dimensions. This training with highest standards of precision is passed on to you in every Continental product. The superior accuracy and greater thread uniformity more than meet your specifications, at no additional cost.

Many times Continental cold forged fasteners have been substituted for expensive screw machine products, improving the product by increasing its strength, while reducing its cost.

Put these standards of precision to work for you on your special orders. It will pay you to call or write us today.

Manufacturers of HOLTITE Fastenings

CONTINENTAL SCREW COMPANY INC. 1904

50th Anniversary

CONTINENTAL SCREW COMPANY

New Bedford, Mass., U. S. A.

¼ to 3 times the input speed) by changing the angular positioning of the axles on which the balls rotate. The result of this arrangement is an infinitely variable and stepless range of output speeds from one constant speed power source. Coaxial input and output shafts rotate in the same direction, either clockwise or counterclockwise.

Operating efficiencies of 75 to 90 percent are reported to be easily maintained over a wide range of operating conditions. Speed is regulated by a simple manual adjustment, with indicator, or by manual or power operated remote control devices. Cleveland Worm & Gear Co., 3249 E. 80th St., Cleveland 4, Ohio.

For more information—
Circle 8, inside back cover

Oscillating Vacuum Pump

Every movement of this pump produces vacuum, according to its manufacturer. There are no pistons or valves —a simple oscillator with a revolving off-center core sucks in air from one side and discharges it from the other. Speed can be varied from 560 to 2015 rpm by interchanging the driving and driven pulleys. The volume of free air that can be moved within these speeds is from 1 to 12 cu ft.

A built-in muffler chamber reduces exhaust noise to a minimum and provides an internal trap to retain a maximum of the vaporized oil from being discharged through the exhaust. The vaporized oil, accumulated in the muffler chamber, drains back into the oil reservoir.

The pump is available with ¼ or ½ hp electric motor and 1½ hp gasoline motor. Package Machinery Co., Springfield, Mass.

For more information—
Circle 9, inside back cover

Miniature Mechanical Chain

A miniature mechanical chain and sprocket system that permits motion transfer through several planes simultaneously without complicated gearing is designed to operate accurately and smoothly around a minimum of a seven-tooth sprocket with a root diameter of 0.250 in. The pitch of the chain is only 0.1475 in. Made of stainless steel to insure high corrosion resistance, the weight of the chain is only 0.45 oz per lineal ft. Standard ⅛ and ⅝ in. aircraft cable can be used with the chain. Special accessory attachments for this are available. Sierra Engineering Co., 123 E. Montecito Ave., Sierra Madre, Calif.

For more information—
Circle 10, inside back cover

Mechanical Seal For High Pressure Sealing

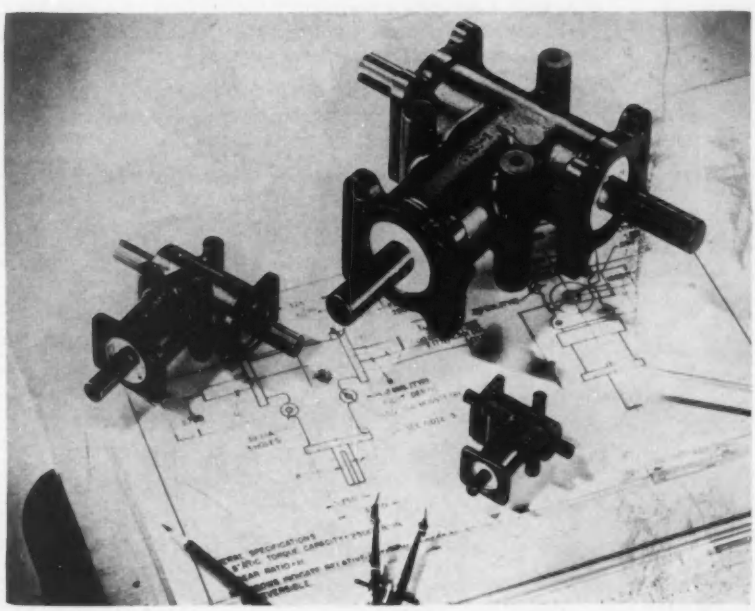
A rotary seal to retain process fluids is designed for pressures of 50 psi to 600 psi, temperatures from −80 F to 400 F. The rotary unit can be fabricated from selected metal alloys for handling all kinds of fluids except molten alkali metals and some fluorine compounds in the higher temperatures. For mounting this new rotary seal, a cut-down shaft or stub sleeve is

Heavy-Duty. Right-Angle Bevel Gear Drive

A heavier, right angle bevel gear unit of 2½ hp rating recently added to this manufacturer's line is available in either two-way or three-way transmission styles. Flanged end-mounting and three-bolt side mounting allow the units to be installed in practically any position required by designers.

These transmissions are 1:1 ratio units with rated speed of 1200 rpm for the new unit. Maximum static torque capacity for this model is 2500 in.-lb. Over-all dimensions of the 2½ hp unit are 12 by 11¼ by 4 in., including the 1-in. dia. shafts. Standard shaft length for this model is 2¾ in. Airborne Accessories Corp., Hillside, N. J.

For more information—
Circle 11, inside back cover



CONTINUED ON PAGE 226

'54 Forecast: MORE ALUMINUM PRODUCTS THAN EVER BEFORE

Reynolds

ALUMINUM REPORTER

MODERN DESIGN HAS ALUMINUM IN MIND

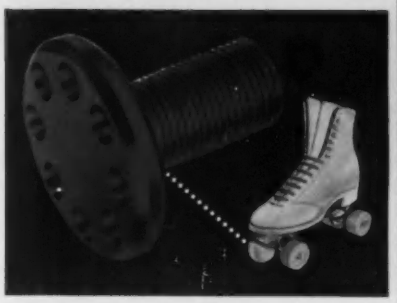
★ ★ ★ Sixteenth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

ALUMINUM IMPROVED AS ELECTRICAL CONDUCTOR

Aluminum Screw Machine Skate Part Has Strength Without Weight

The skate toe stop shown below is made by Ware Brothers Division of Chicago Roller Skate Company. Reynolds 2011-T3 aluminum screw machine stock was selected for the part because it offers ample strength and mass yet is light in weight. This manufacturer of quality skates also uses a forged aluminum foot plate for the same strength to weight advantage.

Job for job, aluminum alloys machine at greater speeds and feeds, thus stepping up production. Unit costs for material, handling and shipping step down because of aluminum's light weight with strength.



For help on alloy selection and prompt delivery on aluminum screw machine stock call your Reynolds Office or Distributor listed under "Aluminum" in your classified telephone directory. Write on business letterhead for your free copy of the 124-page handbook, "Machining Aluminum Alloys." Address Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

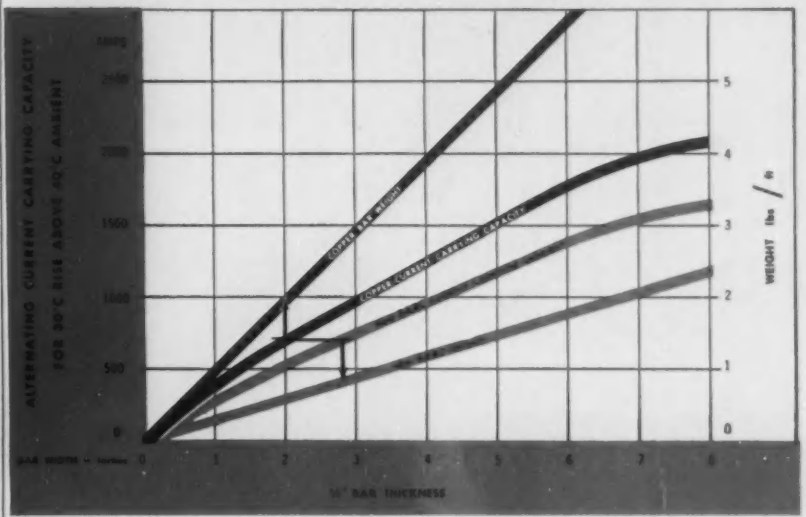
Aluminum Industry Adopts New Alloy Designation System

The Aluminum Association has developed a new system of wrought aluminum alloy designations to supplant various systems previously used. The new system which overcomes inadequacies of the old systems became effective on October first.

To speed transition from the old to the new standard designations the Reynolds Metals Company is offering a simplified conversion chart. Two sizes of the chart are available, one 17″ x 22″ is read easily when wall hung, the other is 8½″ x 11″ for use at desk or drawing board. Both old to new and new to old conversions are shown.

Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky for your free copy of either size chart.

Reynolds Aluminum Development Increases Bus Conductor Strength; Maintains High Conductivity



A new Reynolds development, especially for bus conductor applications, provides greater strength with very little effect on electrical conductivity. An example from the chart above shows why this new material is just what the electrical industry ordered. A current load of 700 amperes requires a copper bar 2″ x ¼″ weighing just under 2 pounds per foot; new RABC (Reynolds Aluminum Bus Conductor) carries the same load with a 2.8″ x ¼″ bar weighing only 4/5 pound per foot. The result is a 60% saving in weight.

New Flexibility in Sizes and Shapes

In addition to providing greater strength advantages RABC is available in an unlimited range of sizes and shapes that permit designing to the minimum amount of metal needed for the current carrying job. It is no longer necessary to specify oversize conductors because of intermediate size limitations. The result is a material cost as low as or lower than for any previous aluminum bus conductor.

Many Cost Advantages

All of the basic advantages of aluminum bus conductor, of course, still hold true. More conductivity per dollar. Long range availability. Excellent resistance to corrosion. And, lighter weight which permits faster, easier handling and saves on installation time and labor costs.

ALUMINUM vs. COPPER BUS CONDUCTOR MATERIALS

PROPERTIES	COPPER	ALUMINUM EC-H17	ALUMINUM RABC
Tensile Strength (psi)	33,000 to 37,500	17,000	29,000*
Yield Strength (psi)	Not Specified	15,000	25,000*
Electrical Conductivity % IACS	98%	61%	55%*
Current Carrying Capacity†	100%	82%	79%
Resistivity @ 20°C (microhms, sq in./ft)	8.31	13.36	14.82
Modulus of Elasticity (lb/in.²)	16 x 10⁶	10 x 10⁶	10 x 10⁶
Density (lb/in.³)	.322	.09765	.09765
Temp. Coeff. of Resistance (% per °C @ 20°C)	.393	.403	.360

*Guaranteed minimum. †For given temperature rise and same cross section

300,000 Volts Plus Is Normal Load for Big Reynolds ACSR

Reynolds Metals Company recently fabricated a special order of Aluminum Cable Steel Reinforced (ACSR) as large as any cable yet made for overhead service in this country. This cable has an outside diameter of 1.76 inches and will be used in a 300,000 volt power system. This is a dramatic example of the advantages resulting from the light weight and electrical conductivity of Reynolds Aluminum.

Send for new descriptive literature on Reynolds Aluminum Bus Conductor and an index of other Reynolds Literature. Write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

Printed in U.S.A.

(Continued From Preceding Page)

Fluted Aluminum Tubing Ideal for Decorative Applications

Exceptionally beautiful effects in the construction of furniture and architectural decoration are being obtained through the use of tubular, fluted extrusions of 6063-T6 Reynolds Aluminum. They can also be used in making outdoor clothes driers and poles, umbrella and vacuum cleaner handles, display racks, clothes trees, ladder rungs and many other useful items. Ladder rungs of this material, for example, have a safer, non-slipping surface.

The new fluted aluminum tubing has an ultimate strength of 32,000 psi, a yield of 25,000 psi and 8% elongation. Data on standard sizes are given below.

Standard Tube Sizes*	Nominal Weight lb/100 ft	Minimum Inside Bend Radii	
		Machine Bending With Mandrel	Machine Bending Without Mandrel
¾" x .050" Wall	12.7	1 15/16"	1 9/16"
⅞" x .050" Wall	13.7	2 1/16"	2 3/16"
1" x .050" Wall	16.0	3 1/16"	2 13/16"
1" x .0625" Wall	20.0	2 5/16"	2 1/16"

*Other sizes available on special inquiry

Smooth surface drawn aluminum furniture tubing for other than fluted finishes, of course, continues to be available in 6063-T831 and 6063-T832 alloys and tempers, in ¾", ⅞" and 1" sizes, with .049" through .065" wall thicknesses. For more complete information write Reynolds Metals Company, 2576 South Third St., Louisville 1, Kentucky.

Reynolds New Master Alloy Aluminum Pigs Cut Foundry Costs

A new concept of reduction pot practices has resulted in the production of two new master alloy aluminum pigs at regular pig prices.

Both new pigs, designated as 2364 and 2393, have been added to the full line offered by the Reynolds Metals Company. Their use in foundries provides improved production control and fewer rejected castings.

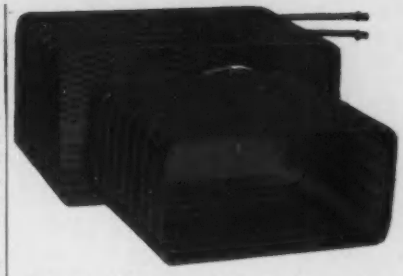
Available in the 50 pound size, these new master alloy pigs provide more uniform analysis through simple blending with secondary metals to control undesirable impurities.

Chemical analysis of 2364 alloy pig is silicon 6%, copper 4%, nominal iron and balance aluminum. 2393 alloy pig has a chemical analysis of silicon 9%, copper 3½%, iron ¾%, balance aluminum. Complete information on these and the family of aluminum pig and ingot products by Reynolds is available from the Reynolds office or Pig and Ingot Distributor listed under "Aluminum" in your classified telephone directory. Or write direct.

Printed in U.S.A.

Roll Bonded Aluminum Sheet Now Produced by Reynolds for Refrigeration Industry

Reynolds roll bonded aluminum sheet is two sheets of aluminum metallurgically bonded together. It is an ideal material for refrigerator evaporators, freezer liners and freezer cold plates. In fact, it should be an economical, efficient and practical replacement for all applications involving heat exchanging where tubing fastened to sheet has been used in the past.



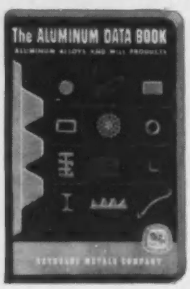
Metal ordinarily used for tubing, accumulators and receivers is eliminated. The passageways are inside the sheet. There are no tubes to bend. Welding is minimized. There is no brazing and therefore no flux contamination. Many connecting and assembly operations are eliminated. There is no problem of lost conductivity. Cleaning time and expense are reduced because there are no deep crevices where tubing meets sheet.

Tubing contours smoothly into the sheet. Expansion, radius and bending problems inherent with tubing are eliminated. You can route refrigerants wherever they are needed. Passageways may be flat, oval or round. They can be smaller and can be placed closer together. Additional length adds nothing to the cost. Reynolds roll bonding is strong and compact. Passageways themselves act as stiffening ribs and contribute to the overall sturdiness of the unit.

For more details on Reynolds roll bonded aluminum sheet or for Reynolds engineering assistance on fabricated parts for your particular products, regardless of your industry, contact the Reynolds office listed under "Aluminum" in your classified telephone directory. Write for your free copy of the 20-page brochure, "Aluminum Appliance Parts" and the 24-page "Catalog of Facilities" to Reynolds Aluminum Fabricating Service, 2065 South Ninth Street, Louisville 1, Kentucky.

New Edition of "Aluminum Data" Offers Valuable Information to Aluminum Users

Reynolds Metals Company has just released the 1954 edition of the "Aluminum Data Book". It contains 220 pages of detailed information on the properties and characteristics of aluminum and is considered the most complete and up-to-date technical information on aluminum now available.



Text and tabular information on physical, chemical and mechanical properties of aluminum as well as data on tolerance, weight, fabricating characteristics, etc. have been expanded.

Entirely new information is presented on radioactive isotopes of aluminum, thermal neutron absorption cross sections for various metals, as well as the elements found in commercial aluminum alloys.

Other new material includes a section on "Availability" showing manufacturing limits on standard aluminum mill products and giving details on aluminum powders, pastes and chemicals. A section is devoted to the new alloy designation system just adopted by The Aluminum Association. New and old system equivalent tables are shown.

Single copies of the book are available to engineers, designers, technical men, instructors and executives without charge when request is made on a business letterhead. Address requests to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Reynolds Begins $2,585,000 Expansion of Sheffield, Alabama Sheet Mill

New melting equipment capable of producing about 90,000,000 pounds of aluminum annually is being installed as the first step in a broad expansion program planned for Reynolds sheet mill in Sheffield, Alabama. This will permit Reynolds to give better delivery to the ever-expanding market for aluminum sheet. Additional annealing facilities consisting of four new furnaces, each with a capacity for 120,000 pounds of aluminum coils are also being added to the plant.

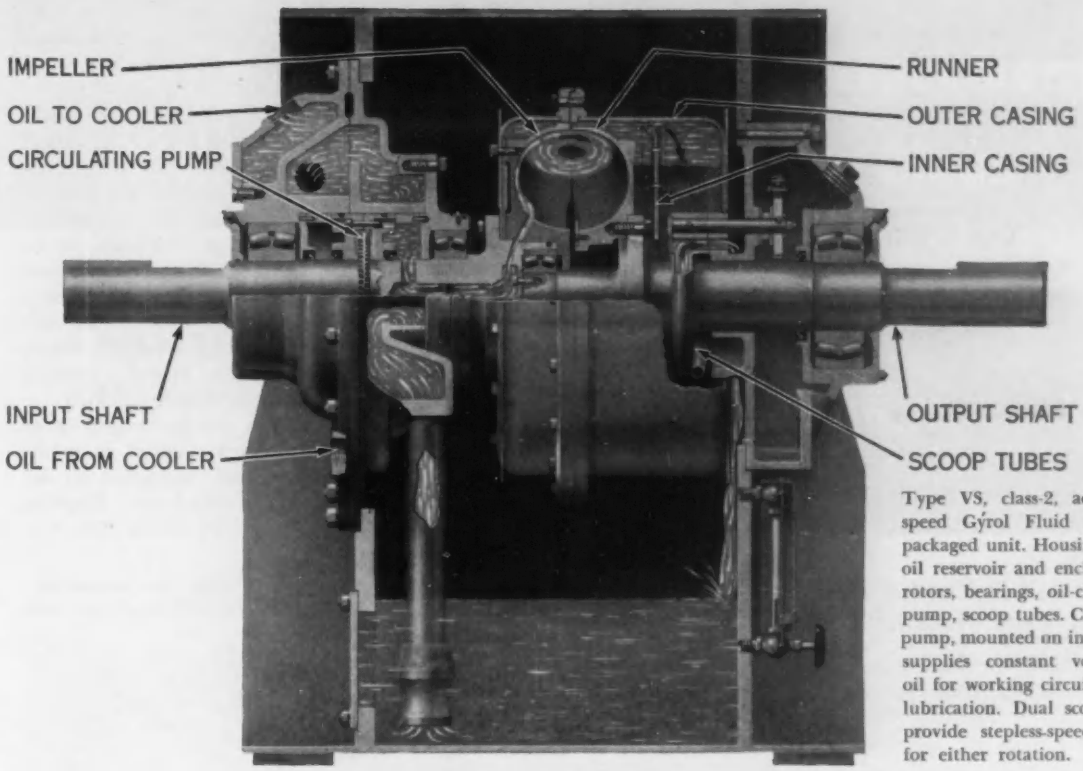
A number of new buildings will be required to house the new melting and annealing facilities.

Fabricators Benefit from Reynolds Design Seal Program

More and more manufacturers are participating in the "Designed in Reynolds Aluminum" Seal program. Applied to the manufacturers' products it tells a stronger quality story at point-of-sale. Reynolds national magazine advertising and outstanding "Mister Peepers" TV show are benefiting Seal program participants.

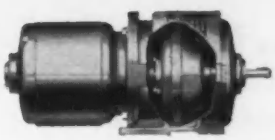
For details on how your company can qualify for the Seal, write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.

(Advertisement)

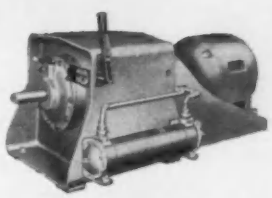


Type VS, class-2, adjustable-speed Gýrol Fluid Drive — a packaged unit. Housing acts as oil reservoir and enclosure for rotors, bearings, oil-circulating pump, scoop tubes. Circulating pump, mounted on input shaft, supplies constant volume of oil for working circuit and for lubrication. Dual scoop tubes provide stepless-speed control for either rotation.

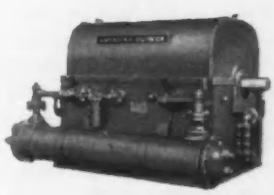
Choose the exact fluid drive you need!



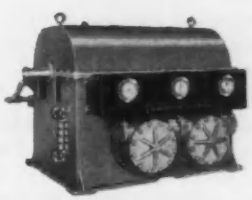
Type TM Gyrol Fluid Drive: motor, traction-type drive in a single unit; 1 to 20 hp; Bulletin 8519. Type T: traction-type less motor; ½ to 200 hp; Bulletin 7419.



Type VS, class-2, adjustable-speed Gýrol Fluid Drive. Speed range: 5 to 1. Six sizes, 7½ through 800 hp; speeds up to 1,800 rpm. Request Bulletins 9419 and 9519.



Type VS, class-4 Gýrol Fluid Drive — an adjustable-speed drive for fans, compressors and pumps, etc. 100 to 2,500 hp; speeds up to 1,800 rpm. Ask for Bulletin 9319.



Type VS, class-6 Gyrol Fluid Drive — adjustable speed drive for boiler-feed pumps, compressors, other high-speed applications. 400-12,000 hp; to 3,600 rpm. Bulletin 8019.

American Blower offers you a complete line of Gýrol Fluid Drives — including the new type VS, class-2, adjustable-speed model

Application possibilities are unlimited with American Blower's Gýrol Fluid Drive line!

For example, the new type VS, class-2, adjustable-speed Gýrol Fluid Drive can be reversed while in motion — at any adjustable operating speed — by merely changing the direction of rotation of the motor! And you can use this compact, self-contained unit in a variety of arrangements of the driving motor.

The standard Gýrol Fluid Drive line includes constant-speed and adjustable-speed units — up to 12,000 hp, and speeds to 3,600 rpm. You'll find there's a Gýrol Fluid Drive to fit practically any application.

For fact-packed bulletins and complete engineering data, get in touch with your nearest American Blower or Canadian Sirocco Branch Office; or write us direct. Do it, today!

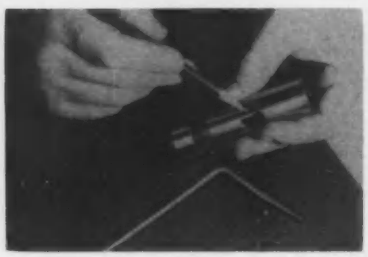
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

required and a packing space of ½ in. clearance or larger. Durametallic Corp., 2104 Factory St., Kalamazoo, Mich.

For more information—
Circle 12, inside back cover



"Keyhole" Drift Slot For Spindle-Type Machine Tools

A reportedly trouble-free tool ejection method for spindle-type machine tools is said to eliminate damage to machine bearings and spindles caused by hammering on conventional drifts. The new ejectors reduce tool-change time on some jobs. Slot design consists of a round top portion which serves as a bushing for the key, and a rectangular slot to permit use of conventional drifts should a tool or adapter become "jammed" in the spindle. The cam-shaped tip of the ejector rotates against the top of the tang, pushing the tool from the spindle in one easy and fast motion. Ejectors are available in five standard sizes for No. 1, 2, 3, 4 and 5 taper spindles. Scully-Jones and Co., 1901 S. Rockwell St., Chicago, Ill.

For more information—
Circle 13, inside back cover

Combination High Pressure Reducing and Relief Valve

A high pressure reducing and automatic relief valve has been designed for low capacity applications. It can be used for initial pressures as high as 4000 psi and reduced pressures from 2000 psi down to zero in accurately controlled adjustable increments. This spring-loaded, diaphragm-operated combination valve is reportedly able to reduce high-pressure air, oil or water pressure and make these reductions down to set point without shock. The built-in relief valve is a precision unit that automatically opens to relieve excess if reduced pressure exceeds setting.

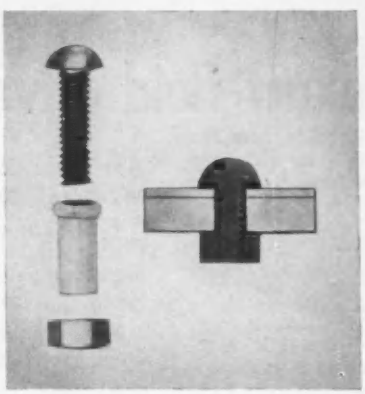
The valve is self-contained and adjustable to required reducing and relief settings. It is available in ⅛, ¼, ½ and ¾ in. sizes. Atlas Valve Co., 280 South St., Newark 5, N. J.

For more information—
Circle 14, inside back cover

Single Revolution Clutch

Designed for flywheel mounting on riveting machines, staplers, small punch presses and similar machines, the Type 4 is manufactured in five sizes with capacity ranging up to 1146 ft-lb torque. Hilliard Corp., Elmira, N. Y.

For more information—
Circle 15, inside back cover



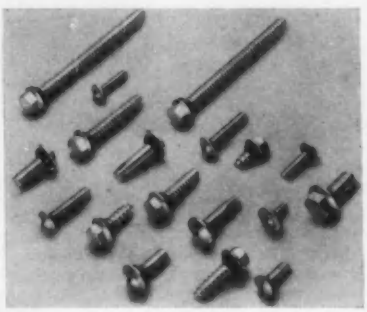
Nylon Sleeve For Bolts, Screws, Rivets

Reducing bolt failure due to vibration, eliminating electrolytic corrosion and providing a leak-proof seal, are some of the accomplishments ascribed to a nylon sleeve or washer that can be used under the head of a bolt, screw or rivet. Manufacturers of tractors, aluminum siding and refrigerators and freezers are said to have stated that more positive sealing against hot oil, cold, moisture and weather conditions at lower cost is provided.

A compressible sleeve that extends from bolt head to nut, made with a rim-flange at one end, the part is either slipped over the bolt or dropped into the bolt hole. As the nut is drawn up on the bolt, the nylon is compressed and cold flows—forming a washer-like disc at both ends. In addition, the nylon flows solidly around the threads of the bolt, providing a positive seal between the bolt and bolt hole. If desired, it is also possible to form a thread disc or buffer between two plates being bolted together.

The sleeves can be ordered in an almost unlimited range of diameters, lengths and wall thicknesses to suit specific job requirements. Keystone Plastics, Inc., 2331 Morris Ave., Union, N. J.

For more information—
Circle 16, inside back cover



Fasteners With Pre-Assembled Washers

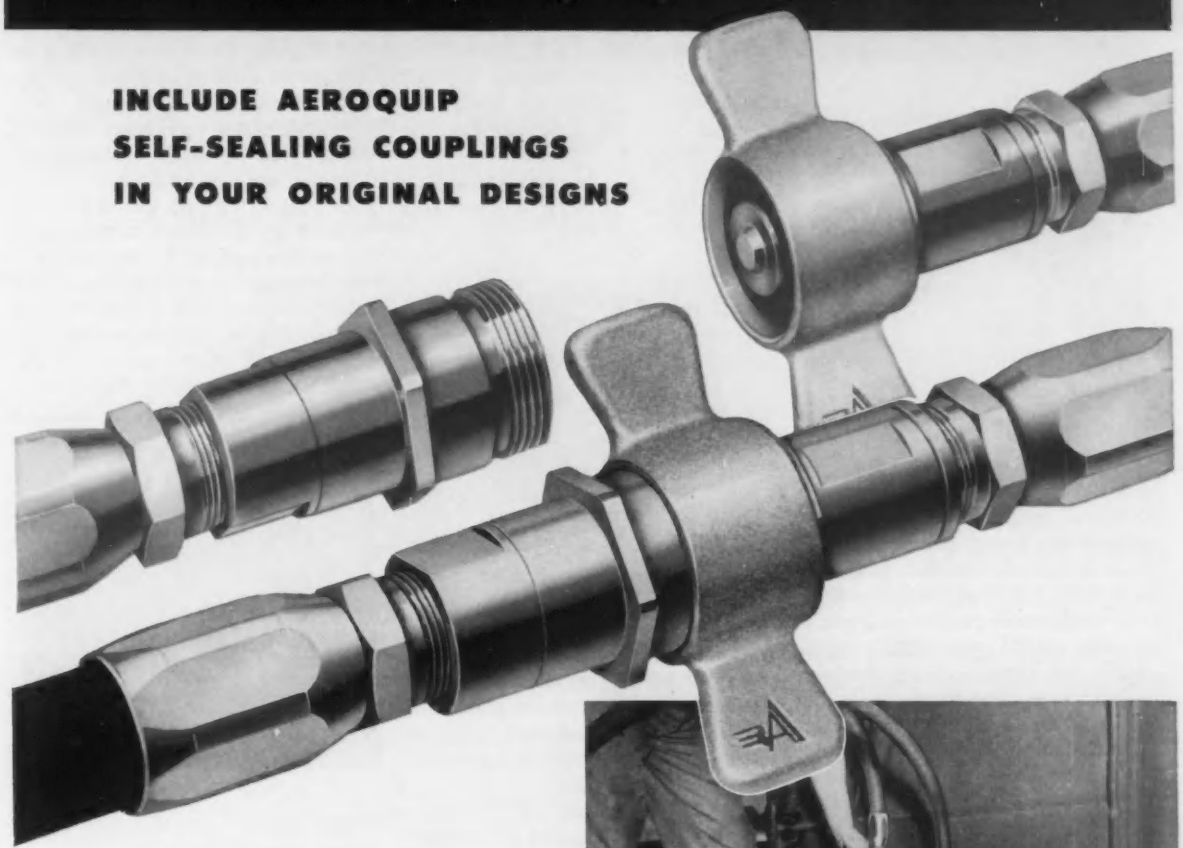
A multi-purpose fastener with a one-piece metal washer-head and assembled synthetic rubber washer has been introduced for use in preventing leaks, for protecting surfaces, absorbing shock and stopping squeaks. When this fastener is seated, an undercut in the washer head is asserted to trap and control the flow of the washer material at the outside edge, forming a water-tight and air-tight seal. The washer also acts as a shock absorber and minimizes squeaks and chatter.

The washers can be pre-assembled and applied to self-tapping screws, thread-cutting screws, drive screws, stove bolts, machine screws, wood screws, nails and special products. The fasteners are available in stainless, carbon and alloy steel as well as nonferrous materials, such as aluminum

CONTINUED ON PAGE 228

For Quick, Easy Changes of Attachments Without Bleeding Hydraulic Lines

INCLUDE AEROQUIP SELF-SEALING COUPLINGS IN YOUR ORIGINAL DESIGNS



Avoid the need for two shut-off valves. One compact Aeroquip self-sealing coupling does the job better. Pressurized hydraulic lines may be disconnected and reconnected instantly . . . no fluid gets out . . . no air gets in . . . interchange of hydraulic attachments is quick and easy.

Aeroquip self-sealing couplings are also recommended for air, oils, fuels, coolants and other fluid lines. See your distributor or write us for information.

Aeroquip Self-Sealing Couplings are used to connect and disconnect pressure and return lines between tractor and trailer with hydraulic dump.

Aeroquip

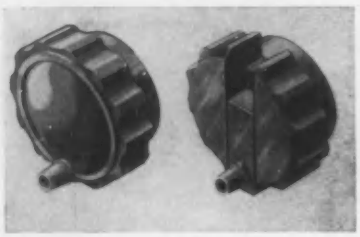
REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

and copper. Screw diameters smaller than No. 6 (0.140 in.) are not recommended. Townsend Co., New Brighton, Pa.

For more information—
Circle 17, inside back cover



Instrument Knobs With Built-in Slip Clutches

A line of knobs designed to safeguard delicate and costly instruments against careless or inadvertent cranking beyond their normal stops can be used for multi-turn devices such as variable capacitors, inductors, potentiometers. The knobs work on the principle of the slip clutch, automatically disengaging and slipping when a predetermined torque is exceeded. The knobs, which are fluted to aid in sensitive adjustment and which have spinners for rapid setting, measure 1⅞ in. OD by ⅛ in. thick, for use with standard ¼ in. shafting. Jan Hardware Mfg. Co., Inc., 75 N. 11th St., Brooklyn 11, N. Y.

For more information—
Circle 18, inside back cover

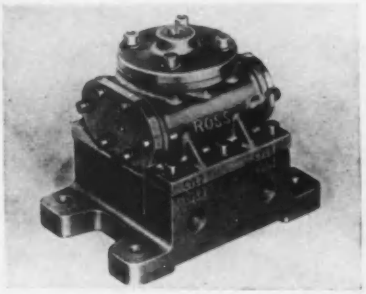
Stainless Steel, Solenoid Operated Valve

This two-way valve is designed to control gases and liquids generally corrosive to bronze, steel or iron at pressures to 250 psi. They are normally closed valves.

Heavy duty construction throughout is reported to make valves suitable for operation at a frequency of 400 times per min. Solenoids are of floating core construction which provides freedom from core chatter.

All internal parts are readily accessible without removing valve body from pipe line. Sterilizing or cleaning can be done by merely removing valve bonnet. Continuous duty Class A coils for temperatures to 212 F are provided. High temperature Class H coils are supplied for temperatures to 450 F. Available in ⅜ in. IPS solenoid enclosures to meet NEMA standard watertight requirements. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

For more information—
Circle 19, inside back cover



Remote Controlled Valve

This valve is a four-way, base-mounted, pressure-operated model controlled by air from a remote pilot valve which may be hand, foot, cam or solenoid actuated. Both actuation and reversal are immediate.

Standard models include side ports, ¼ through ¾ in. pipe sizes. The 1 and 1¼ in. sizes are bottom ported. Main valve pressures can go to 125 psi and pilot air pressures may be equal to or greater than main valve pressures, but not less than 30 psi. Operating temperatures can go up to 175 F. Ross Operating Valve Co., 120 E. Golden Gate, Dept. R3104, Detroit 3, Mich.

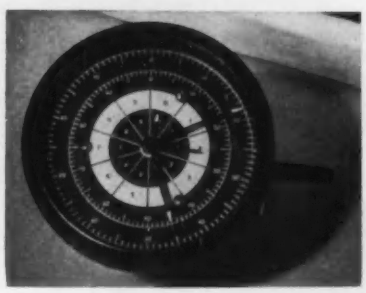
For more information—
Circle 20, inside back cover

Flexible Belt Conveyor Idler

A cable-suspension idler for belt conveyors provides a load-conformity catenary, cushions the belt, and handles both bulk and packaged materials. It uses two bearings, and carries the belt on resilient, pressure-molded synthetic rubber discs, all of the same size and all revolving at the same peripheral speed. Discs are molded to a synthetic rubber-sheathed steel cable.

In continuous contact with the loaded belt, the discs exert a slight gripping action that holds slippage to a minimum, and tends to keep the belt aligned. Discs have excellent resistance to abrasion, and will not support combustion. They resist most chemicals except very strong oxidizing agents and aromatic hydrocarbons. Bearings are supported above and to each side of the belt, out of the dirt zone. They are locked in place with spring clips and can be changed without interrupting material flow. The idler permits conveyor heights from 13¼ to 15¾ in., and is available for belt widths of 24, 30, and 36 in. Joy Mfg. Co., Pittsburgh 22, Pa.

For more information—
Circle 21, inside back cover



High-Speed Mechanical Counter

Based on a new type of low-inertia mechanism, this cumulative counter is conservatively rated for production-control applications rated at up to 3,000 per min. Capable of containing counts up to 999,999, the unit registers with four pointers on four concentric scales reading from the center outward.

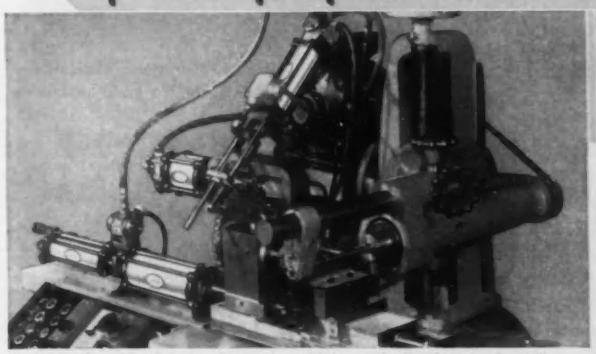
Besides the low-inertia mechanism which minimizes error from carry-over, the instrument features an exclusive pawl and pinion drive with an interlocking device designed to prevent multiple counts.

Housed in an anodized aluminum case, the Model 550 has a full-sized bezel and convex plastic front window. The case is arranged for either flush-panel or projected mounting, the actuating lever being brought out the

CONTINUED ON PAGE 230

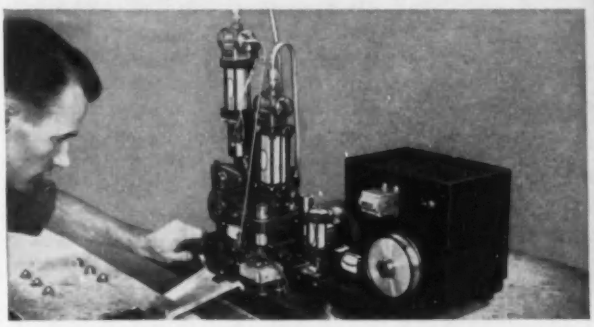
With one or more of these "packaged" power units . . .

. . . you can build quickly in your own tool room special purpose, cost saving machines like these:

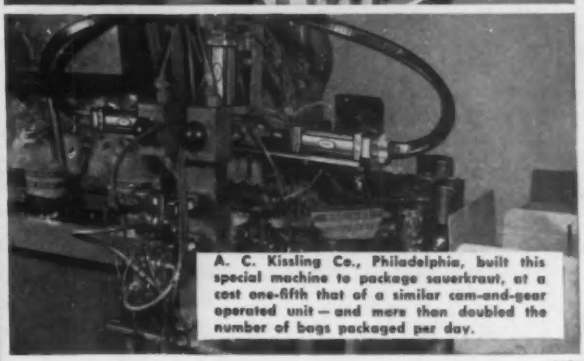


Acetogen Gas Co., Detroit, obtained a 600% production increase in milling splines for their gas cutting torch tips, with this special machine built around Bellows air equipment.

This special testing machine, built around Bellows "Controlled-Air-Power" Devices, increased production from 1,300 parts per day to 3,000 parts per day at the plant of Allis Seal Co., Chicago.



Radio Receptor Co., Inc., Brooklyn, N. Y., designed this tool-room-built cut-off and forming machine and jumped production over the old method by 350%.



A. C. Kissling Co., Philadelphia, built this special machine to package sauerkraut, at a cost one-fifth that of a similar cam-and-gear operated unit — and more than doubled the number of bags packaged per day.

1009A

The next time you get a chance, take a critical look at some of your routine operations — particularly those you've been handling the same way for the past four or five years. There are cost-savings there you shouldn't overlook.

The four illustrations on this page are typical of the ways that Bellows "Controlled-Air-Power" Devices and a little ingenuity can team up to accomplish big savings. It's worth checking into.

WRITE FOR THIS FREE 36 PAGE BOOKLET

Here in these quick-reading pages is the story of "Controlled-Air-Power" — what it is doing for others — what it can do for you. It's free on request. Dept. PE-1254. The Bellows Co., Bellows Bldg., Akron 9, Ohio. In Canada, write to: Bellows Pneumatic Devices of Canada, Ltd., Toronto

The Bellows Co.

AKRON 9, OHIO

FIELD ENGINEER OFFICES IN ALL PRINCIPAL CITIES

side through a dust-sealing rubber boot. Dimensions are 3½ in. dia., 2 in. deep. Weight is 6 oz. Raycon Corp., 901 Willow St., Redwood City, Calif.

For more information—
Circle 22, inside back cover

Forged Needle Valve With Universal Outlets

With stainless steel stems, the bodies of these valves are forged from brass, stainless steel or carbon steel. It is claimed that the wide range of optional machinings on outlets facilitate lower cost installations. Also furnished with mountings for instrument panels. Carpenter Valves Corp., 6723 Deniso nAve., Cleveland 2, Ohio.

For more information—
Circle 23, inside back cover

Small Die-Cast Counters

These counting mechanisms are available in ratchet style (with either internal or external stops) ratchet rotary, direct drive and revolution. All are available in three, four and five figures capacity, with either base flange or window flange for panel mounting. Two directions of rotation are provided, top going or top coming, and the drive may be on the right or left side of the counter.

Approximate dimensions are ¾ in. wide by ⅝ in. high; flange is 1¼ in. long and shaft extension is ⅜ in. The weight is about 2 oz. The speed range is from 500 to 1000 counts per min. Durant Mfg. Co., N. Buffum St., Milwaukee 1, Wis.

For more information—
Circle 24, inside back cover

Piston Seal Simplifies Power Actuator Design

As a long stroke, piston seal diaphragm with the "O" ring bead seal characteristic, this seal is said to function efficiently at pressures up to 500 psi or up to ten times the maximum of ordinary diaphragm seals. Use of the new flangeless design in power applications permits longer stroke, easier application and much lower cost per stroke. Bead, rather than flange design, and wall thickness of only 0.050 in. makes possible smaller, lighter, less bulky actuators. Dynamically stable, this new diaphragm will tolerate considerable misalignment and adapts itself well to rough applications. Bellofram Corp., 144 Moody St., Waltham 54, Mass.

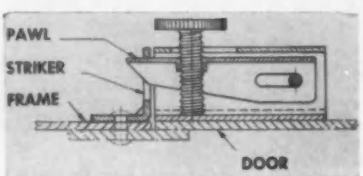
For more information—
Circle 25, inside back cover

Equipment Pull Handles

Injection molded of black cellulose acetate butyrate, these handles are available in either matte or mirror finish. The matte finish handles meet the requirements of the 16E4 (Ships), MIL-E-16400 (Ships), MIL-E-5400 and MIL-P-11268 (Signal Corps), while the mirror-finished handles blend with the mirror-finished knobs on the instrument panels of commercial equipment.

The new handles are said to permit easier handling of rack-mounted electronic equipment when removal is necessary. Raytheon Mfg. Co., Waltham, Mass.

For more information—
Circle 26, inside back cover



Sliding Latch Pulls Access Panels Tight

Access doors and panels, either hinged or removable, are drawn up tight against frames or gaskets by a turn on the knob of an inexpensive sliding latch. Vibration is said to cause no rattling of panels secured by the latch.

When space inside the door or panel is limited, or where sanitary requirements would forbid inside use of fastener parts, the latch is installed entirely on the outer surface of door and frame. Four rivets or screws attach the fastener to the door, and two more attach the striker to the frame. Nothing but the rivet heads project through to the inside.

Where space is available inside the door, an alternate model conceals all parts but the knob behind the door surface. This model requires no striker since the pawl slides directly behind the door frame.

Precise alignment of fastener pawl and striker is not necessary and the unit's inherent tolerances allow for variations in panel thickness up to ¼ in. South Chester Corp., Lester, Pa.

For more information—
Circle 27, inside back cover

Nut for Electrical Conduit and Fittings

Easier installations in locking electrical conduit and fittings at panel and junction boxes is said to be provided by a redesigned nut made of formed steel, galvanized after thread cutting. The new ¾ in. nut has four large, perpendicular lugs, which permit easier tightening with a screwdriver. It also has sharp, beveled bonding teeth on one side which easily cut into the metal wall of panel and outlet boxes for metal grounding and vibration-proof lock. National Electric Products Corp., Gateway Center, Pittsburgh, Pa.

For more information—
Circle 28, inside back cover

Silencer Doubles As A Manifold

Designed for use on a generator set powered by a gas engine, this muffler is reported to save weight and makes possible a smaller, more compact generator set. No manifold is required, since the silencer is mounted directly on the entire block by means of a flange.

As exhaust bursts enter the chamber of this silencer they are directed through louvers along the outer shell

CONTINUED ON PAGE 232

How Cindus X-CREPE® outperforms "traditional" burlap* in furniture roll edging

*If you use burlap or comparable material in any way (including bale wrap), it will pay you to look into the characteristics and advantages of Cindus X-Crepe, the new basic material.

X-Crepe stabilizes materials costs, helps slash installation time 90%

Burlap—traditional material of many uses—has been replaced by Cindus X-Crepe in roll edging, a furniture component made by Flex-o-lators, Inc., Carthage, Mo. X-Crepe outperforms burlap, gives these important advantages:

Stabilized materials costs—Eliminates jumpy, undependable burlap prices from their cost structure.

Makes roll edging easier to use—Now Flex-o-lators' roll edging can be bent sharply into neat, square corners *without mitering*—or can be smoothly "crimped" for curved chairs, modern sectionals and the like. Far simpler than previous methods.

Slashes user's installation time 90%, gives Flex-o-lators big sales advantage—X-Crepe accepts wire hog rings, eliminates hand sewing, gives user's furniture neat, tailored edges with greatly reduced labor costs—now one of Flex-o-lators' biggest competitive sales points.

Makes product tougher, practically indestructible—In an endurance test, 1,350,560 brutal poundings *broke a steel spring*, but left attached X-Crepe roll edging unharmed! It showed no wear and had not slipped or torn away from its original position.

Let us know your materials problem. Our research staff can work wonders at tailoring X-Crepe to suit your exact needs. We'll help you improve your product and reduce its cost.

Flex-o-lators reports X-Crepe simplifies fabrication, chops hours from production schedules. Unlike burlap, X-Crepe can be fed from continuous rolls, easily slit and sewn—makes whole operation speedier, more automatic.

X-Crepe's unusual formability, extra strength, built-in "give", resistance to tearing, all around toughness, make it ideal as a replacement for burlap. For many applications it can also replace materials like cork, rubber, felt and other kinds of cloth—almost always at a considerable cost saving!

In addition, X-Crepe can be impregnated, coated, laminated, made waterproof, combined with cloth and fibers, films and foils to extend the use of such materials far beyond their usual limits.

Write today for your Free Cindus Design Engineer's Portfolio, containing samples and complete information. Fits conveniently in your files.

cindus TRADE MARK

®X-CREPE is the trademark of Cincinnati Industries Inc. for its double-crepe products.

CINCINNATI INDUSTRIES INC. 362 CARTHAGE AVE., CINCINNATI 15, (LOCKLAND) OHIO

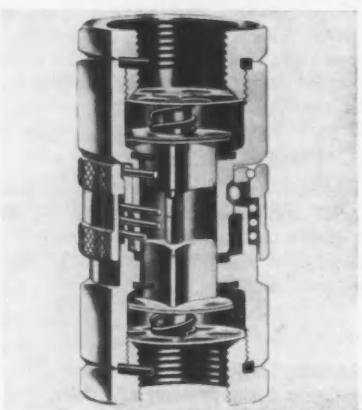
which cools them and reduces their volume. More louvers direct the gases back into the center of the silencer and out into the atmosphere. The new silencer is made of stainless steel and is welded throughout. Kittell Muffler & Mfg. Co., 915 S. Santa Fe., Los Angeles, Calif.

For more information—
Circle 29, inside back cover

Automatic Moisture Unit For Air Lines

Used for separating moisture and other contaminants from compressed air lines, the Series 150 is now available for ¼ to 3 in. lines. Operating pressures are 10 to 250 psi. These float units are designed for either continuous or intermittent flow lines and operate without pressure drop and with no flutter. Because the float merely triggers the moisture discharge rather than actually opening and closing the port, efficiency of these units is said to be one of the highest known. A built-in filter screen protects operating parts against rust and grit. Wilkerson Corp., 3387 S. Platte R. Dr., Englewood, Colo.

For more information—
Circle 30, inside back cover



Quick Connect-Disconnect Coupling

Available in ⅛ to 10 in. ID, this coupling's metal-to-metal valve stop in the closed position permits positive control of the compression of the valve washer sealing member regardless of surge or pressure build-up in the line. A new type of barrel spring, with a perforated "spider", full circle valve stop and guide, holds valves steady in open position, allowing no valve float, and permits high pressures and surges in both directions through the coupling or even rapidly pulsating surges in both directions.

Alloy steel is standard material in the "H" series coupling. Snap-Tite, Inc., 201 Kelly St., Union City, Pa.

For more information—
Circle 31, inside back cover

Coupling for Pressure and Vacuum

With interchangeable sockets and plugs, this series of couplings is said to handle jobs using ¼ to ½ in. connections, from the air line to the air tool. Consequently, there is no need for various sizes of couplings at different points in the hook-up or for maintaining large inventories of various sizes and types of fittings.

Equipped with an automatic sleeve lock, the Series 3-RL is quickly and positively connected by pushing the plug into the socket. To disconnect, it is necessary to turn the sleeve.

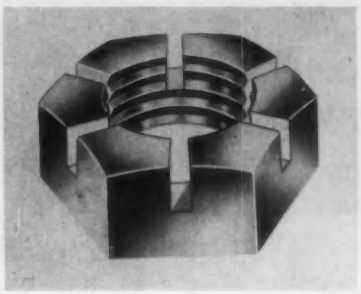
Sockets of this series are brass with steel sleeves. Plugs are steel. Sockets for use with small hand-operated air tools are available in aluminum. Hansen Mfg. Co., Cleveland, Ohio.

For more information—
Circle 32, inside back cover

Self-Tapping Set Screws

These self-tapping set screws are available in a full range of sizes down to as small as No. 2-$\frac{28}{32}$. In addition to being self-tapping, these new set screws are said to be self-aligning and self-locking, yet easily removable when desired. The cutting thread extends only around the top or slotted section and offers two cutting edges, which enables it to cut on both sides of the hole; the shavings, instead of accumulating below, are gathered in the slot. Due to its unique design, the screw is said to "pull itself in". It can be supplied with any type of set screw point. Set Screw & Mfg. Co., 153 Main St., Bartlett, Ill.

For more information—
Circle 33, inside back cover



One-Piece, Free-Spinning, Reusable Locknut

The upper portion of this nut is slotted and the bottom face is undercut, so that when the nut is tightened, the threaded upper segments move inward, causing the nut to produce a vibration-proof lock on the threads of the screw. The new locknuts are made in all machine screw sizes in steel, brass or aluminum. Jacobson Nut Mfg. Corp., Kenilworth, N. J.

For more information—
Circle 34, inside back cover

Fittings Flare Tubing Automatically

A line of pressure-tight fittings have been made available in ¼, ⅜ and ½ in. sizes in a variety of types and materials. These fittings are said to eliminate the need for preflaring the tubing. As the nut is tightened with an ordinary wrench, tubing is flared automatically inside the fitting, forming the standard 37 deg seat required by SAE and JIC specifications. Mated surfaces of tube and internal flaring cone assure a leakproof connection. Since tubing does not rotate during tightening, tube installation may be performed before assembly.

Among the types of fittings being

CONTINUED ON PAGE 234

HOW TO BEAUTIFY ACOUSTICAL TILE ...AND KEEP IT QUIET!

Back-and-forth . . . back-and-forth . . . travel these horizontal spray units. They are transforming the natural tan color of acoustical tile into a soft, clean shade of white.

This finish is a special emulsion formula developed for the new fully automatic tile production line at the Newark, Ohio, plant of the Owens-Corning Fiberglas Corporation. Called Glidden Acoustical Tile Coating, it meets all standards of light reflectance, appearance, and fire retardment, yet does not reduce the sound-deadening properties of the tile.

That's it: further proof of the versatility of Glidden Technical Service—available to all of industry.

THE GLIDDEN COMPANY

INDUSTRIAL FINISHES DIVISION

11005 Madison Avenue • Cleveland 2, Ohio

SALES OFFICES AND FACTORIES:

San Francisco, Los Angeles, Chicago (Nubian Division—1855 North Leclaire Avenue), Minneapolis, New Orleans, St. Louis, Cleveland, Reading, Atlanta; Canada: Toronto and Montreal.

made are male, female and union connectors, 90 deg male elbows and tees. Brass fittings are available for copper tubing applications. Fittings are also made of anodized aluminum, cadmium-plated steel, Monel and stainless steel. Century Products, 315 S. 15th St., Philadelphia 2, Pa.

For more information—
Circle 35, inside back cover

Positive Break-Away Hose Coupler

This coupler couples with full pressure on both sides of the line. It has a positive break-away action, withstands hard usage and is designed to meet equipment manufacturers requirements.

Nylon valve seats are used to insure positive self-sealing. It can be mounted individually or in tandem and is made in a $\frac{1}{2}$ in. size adaptable from $\frac{1}{4}$ to 1 in. All types of flexible hose may be used with this coupler. Dukes Co., Inc., 2108 N. Southport Ave., Chicago 14, Ill.

For more information—
Circle 36, inside back cover

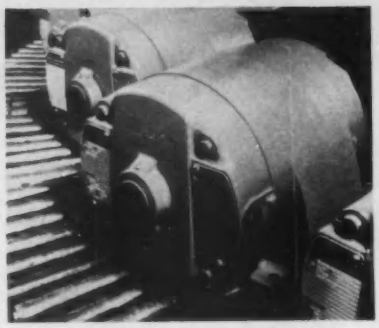
Threaded 45 deg Angle Connectors

Connectors for attaching armored cable to any threaded electrical outlets are made of an aluminum die-cast alloy. Parallel ridges or serrations on the lip of each of the two halves of the new device match standard $\frac{1}{2}$ in. IPS female threads in switch boxes, motor housings, condulets. Operating on a simple cam-wedge principle, it is possible to install this connector from the outside of the box or housing after the wiring hook-up is completed. Positive positioning of the cable connector assembly in any desired direction is assured when two standard machine screws are pulled up on the cable. The only tool required is a screwdriver.

These $\frac{3}{8}$ in. connectors bear the UL seal of approval. Unimatic Corp., Route 22 and Koehl Ave., Union, N. J.

For more information—
Circle 37, inside back cover

POWER AND CONTROL



Single-Phase Capacitor Motor

These motors are built to the latest re-rated NEMA standards. Rigid cast-iron construction and a new insulation system, bearing assembly and ventilation design are also included in their design. Higher full-load speeds and overload capacity are assertedly provided.

Starting of the new motors is accomplished by a simple centrifugal mechanism which throws out when the motor is up to speed, disconnecting the starting capacitors and switching the windings from starting to running condition. The transfer switch is a totally-enclosed, snap-action switch with contacts protected from foreign matter to assure contact.

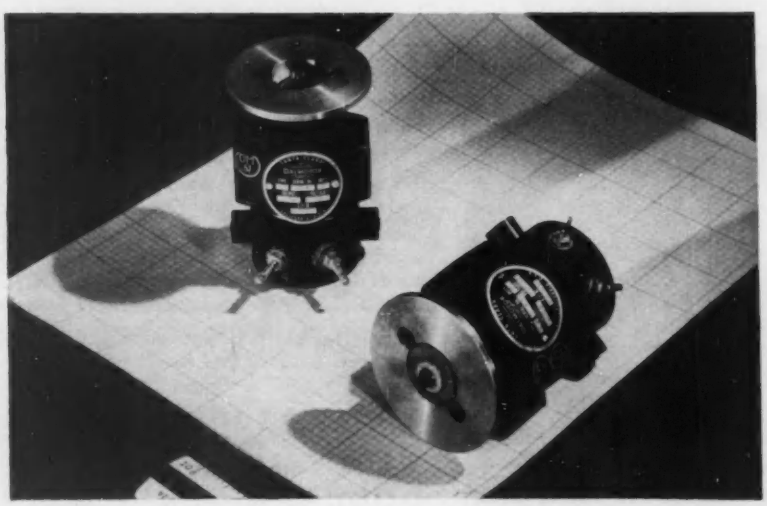
A fibre terminal board is easily accessible behind a cover plate at one end of the motor. By reconnecting the leads, the single-phase motor can be changed from 115 v, 60 cycle to 230 v, 60 cycle operation. By inter-

Flange-Ring, Permanent Magnet Motor

This motor provides a flange-ring mounting for quick attachment by clamps or retaining rings, as well as motor connections to snap in terminals. Rated at 27 v, dc, the motor provides 20-w output at 6,000 rpm on a continuous-duty cycle, including a large overload capacity. It is said to be over 60 percent efficient with good speed regulation and internal capacitor to minimize r-f interference.

Motor is available in a number of styles including output shafts with splines, tangs and other arrangements, as well as alternative types of electrical connections. Dalmotor Co., 1362 Clay St., Santa Clara, Calif.

For more information—
Circle 38, inside back cover



CONTINUED ON PAGE 236

Compact Low-Cost SKINNER Solenoid Valve For Thousands of General Service Applications

No other valve can match the utility and economy offered by the Skinner V5 (Universal) Valve. It is Underwriter approved for all-purpose service, and is suitable for all common media. Its applications are virtually unlimited, and include use on aircraft, automotive, chemical, dental, refrigeration, drink dispensing, heating, industrial, pilot and process control, and instrumentation equipment.

Valves of this series give fast dependable operation — *through millions of cycles.* They are direct acting, spring loaded, *leakproof* . . . and perform perfectly in any position, in ambient temperatures from minus 250°F. to plus 450°F. Available in a broad selection of types, electrical outlets, port locations and sizes, flow adjustments and coil types.

Also available with "Quick Exhaust" for extra fast cylinder return.

Media — Air, gasoline, inert gases, kerosene, oils, water, steam and many semi-corrosive media.

Pressure Rating — 0-1000 p.s.i.

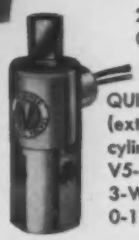
Construction — Leakproof sealing, bubble-tight shut-off at all ports; packless, frictionless construction; stainless steel internal parts; moisture-resistant, varnish-impregnated coils.

Specifications — *Type* — Two- or three-way, normally open or normally closed, or with directional control.
Duty Cycle — Continuous or intermittent.
Orifice Diameters — 3/64" to 1/4"
Pipe Size — 1/8" or 1/4" NPT.
Voltage — all common AC and DC voltages.
Power Consumption — 10 watts.

Do you have a special solenoid valve problem? Rely on Skinner's nationwide resident engineers and highly-skilled Skinner plant engineers to give you expert assistance and service. And for prompt delivery, count on your nearby Skinner stocking distributor.

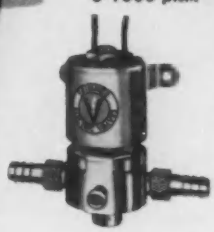
GENERAL SERVICE & VACUUM
V5 Series
2- & 3-Way
0-1000 p.s.i.

MINIATURE CUT-OFF
V2 Series
2-Way
0-250 p.s.i.



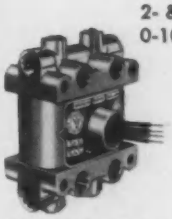
QUICK EXHAUST
(extra fast cylinder return)
V5-3 Series
3-Way
0-150 p.s.i.

HI-PRESSURE HYDRAULIC
V10 Series
2- & 3-Way
0-1000 p.s.i.

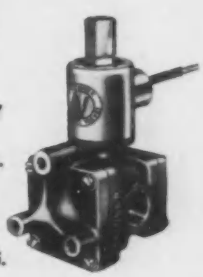


SANITARY
V4 Series
2-Way
0-20 p.s.i.

EXPLOSION-PROOF
X5 Series
2- & 3-Way
0-1000 p.s.i.



ALL-PURPOSE FOUR-WAY
V9 Series
4-Way 0-150 p.s.i.



HI-FLOW INDUSTRIAL
M Series
2- & 3-Way 5-150 p.s.i.

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Company.....
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City.....*Zone*....*State*.....

SKINNER ELECTRIC VALVES

® THE CREST OF QUALITY

changing two leads, motor rotation can be reversed.

The motor is available with the following mountings: standard, foot-mounting, vertical, "D"-flange and "C"-face, close-coupled pump or resilient-base. All of these, in turn, are available in either the standard drip-proof enclosure or the totally-enclosed, fan-cooled enclosure. Ratings are from 1 to 5 hp. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 39, inside back cover

Automatic Stop Control For Vibrating Equipment

An automatic stop control designed to replace mechanical snubbing supplies electrical energy to plug-stop the motor safely without imposing high torque on either the motor or drive. The new control consists of a magnetic reversing switch, thermal relay units and pneumatic timers. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

For more information—
Circle 40, inside back cover

Fan-Cooled, Wound-Rotor Motor

What is said to be the first rib-type enclosed, fan-cooled wound-rotor motor to be made with slip rings, brushing rigging and with rotor and stator inside a single frame enclosure is available at 1800 rpm and slower speeds, in frames 284, 505, in standard enclosed or explosion-proof construction.

In general, the new motor is applicable where very low starting current, high starting torque, smooth acceleration, jogging or variable adjustable speed dictate the use of a wound-rotor motor and where moist, dirty, corrosive, or hazardous atmospheres require a totally enclosed motor.

The frame of the motor has an extended front end to include the slip rings, brushes and brush rigging in one enclosure. The elongation provides added surface for heat dispersal. Removal of two large pipe plugs from the upper quadrants of the frame on the slip-ring end provides large openings for maintenance work and adjustment of brushes and brush rigging. Slip-ring leads enter a separate cast-iron conduit box and the lead opening in the frame is sealed. Allis-Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

For more information—
Circle 41, inside back cover

Water Heater Control

A water heater control, designed for mounting outside the water heater shell yet thin enough for easy concealment, is $1\frac{7}{8}$ in. thick, $4\frac{13}{32}$ in. high and $4\frac{1}{8}$ in. wide. It is suitable for service with all gases.

The body of the heater is a die-formed pressure casting. It has a snap-on aluminum cover, available in various colors. Robertshaw-Fulton Controls Co., Lynwood, Calif.

For more information—
Circle 42, inside back cover

Armored Mill Motor Of 500 Hp

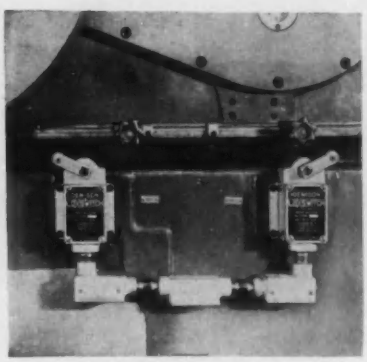
Designed and tested for heavy-duty work in mining and steel-mill applications, this motor is too large to be covered by present standards of the AISE, but rigidly adheres to requirements set up for smaller motors of this type. The new motor incorporates a universal enclosure, which is reported to make possible five systems of ventilation and protection by simply substituting different types of covers on the frame openings.

To lessen the possibility of damage to the coils and fan when the armature is removed, feet have been added to the frame heads for armature support. Connections between halves of the motor outside the frame provide easier accessibility, while an armature spider has been installed to provide for replacement of the shaft without disturbing the windings.

The design makes possible better regulation at high speed, and at the same time provides for a maximum safe speed 20 percent higher than previous models. A lower inertia makes possible a faster operating cycle, according to the manufacturer.

The new motor has already found use in the large power shovel field. It is expected that the new armored mill motor, which is rated at 500 hp at 350 rpm, will find application driving hoists and ore unloaders in coal and ore mining operations, and for shear drives, mandrel coilers and other heavy-duty drives in large steel mills. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 43, inside back cover



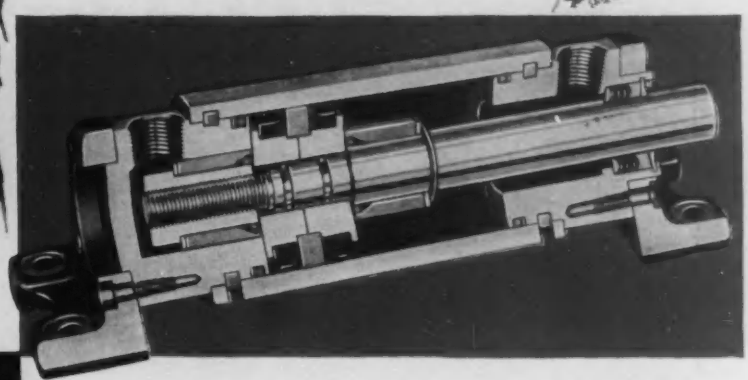
Limit Switches Provide 70 deg Overtravel

The 70 deg overtravel is provided in either direction of the lever. Its purpose is to facilitate faster installation by providing an additional safety factor, and also to provide greater protection against switch breakage and damage.

All models provide isolated circuits with double-break contacts. The standard switch carries a single-pole, double-throw contact arrangement which

CONTINUED ON PAGE 238

BUILT TO LAST...



O-M CYLINDERS *(air-hydraulic)*

Designed and engineered with the user in mind, O-M Cylinders embody every essential construction and mechanical feature to assure trouble-free performance and long service.

They are built of steel with bearing surfaces of bronze—precision machined with modern equipment.

Cylinder bores are honed to a fine finish, and the hi-tensile piston rods are polished to give long life and smooth performance.

Effective O-ring static seals are backed up to prevent extrusion under high pressures. All packings are self-adjusting and are carefully selected for proper usage.

A rigid inspection at the factory is your guarantee of peak performance.

O-M Cylinders fit where others won't because O-M special interlocking mechanism eliminates bulging tie rods and end caps.

Available in a full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. *14-day delivery on most sizes.*

fit where others won't

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Company_____

Address_____

City_____ Zone____ State_____

may be used as normally open or normally closed in either direction, or as maintained contact in both directions. The switch is also available as a double-pole, with both circuits normally closed or normally open and with a three-pole arrangement, two closed, one open. Various mounting plates and levers are available. R. B. Denison Mfg. Co., 102 St. Clair Ave., N. W. Cleveland 13, Ohio.

For more information—
Circle 44, inside back cover

End-Mounting FHP Motors

This fhp motor is equipped with a special new grease for increased bearing life. The new lubricant, it is claimed, aids the ball bearings to absorb heavy end-thrust loads. A large, cast aluminum fan provides a quiet, effective cooling system. The new motor is available in open and totally-enclosed, fan-cooled models, NEMA size 56C face mounting.

The capacitor-start and polyphase open models are especially designed for operation of close-coupled centrifugal pumps. Mounted either vertically or horizontally, they are suited for continuous or intermittent operation. Both models are available in ratings of ¼ hp, 1725 rpm, to 1 hp, 3450 rpm. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 45, inside back cover

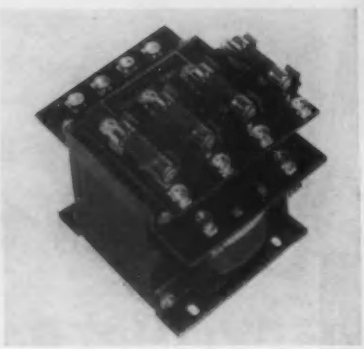
Process Temperatures Sensed, Transmitted

An instrument which accurately measures process temperatures and pneumatically transmits the information to a central recording or controlling station has been announced. It is a nonindicating device of the "force-balance" type, with a calibrated accuracy of ½ percent of the temperature span and compensated for ambient temperature and barometric pressure variations.

The new transmitter is designed around a gas-filled thermal system which exerts force on a flapper-nozzle mechanism in proportion to the measured temperature. The resulting back pressure in the nozzle circuit, amplified through a relay and converted to a force through a bellows, quickly balances out the initial force and constitutes the 3 to 15 psi output transmitted by low-cost tubing to the receiving instrument.

Spans ranging from 50 to 400F are available and can be utilized between the limits of -100 F and 1000 F. A block and clamp mounting arrangement rigidly secures the 7-lb instrument to any vertical or horizontal pipe or to a flat surface. Foxboro Co., Foxboro, Mass.

For more information—
Circle 46, inside back cover

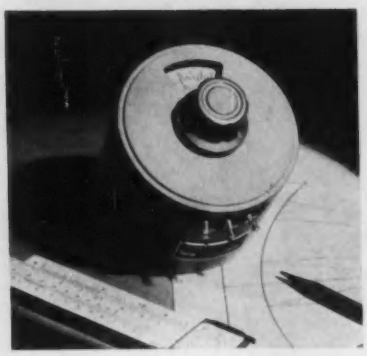


Machine Tool Transformer

This line of transformers includes eight volt-ampere ratings, with which there are 100 combinations of frequency, voltage, physical arrangement of terminals, cable leads and circuit protection. The many accessory devices necessary in most applications of machine tool transformers have been factored into the individual design of each rating, according to the maker. This makes possible significant savings in space. Panel area previously required for fuses, circuit breakers, and wiring may now be utilized in other ways, or the panel size decreased.

In each of the multiple ratings, connecting links are provided for easy change-over from series to parallel connections, eliminating the need for panel manufacturers to supply additionoal jumpers. The transformers are available in ratings of 50, 75, 150, 300, 500, 750, 1,000, and 1,500 v-amp. For each rating there is a domestic unit for 60 cycles, 230/460 v primary, 115 v secondary, and a combination domestic export unit for 50/60 cycles, 230/460/575 v primary, 115/95 v secondary. General Electric Co., Schenectady 5, New York.

For more information—
Circle 47, inside back cover



Voltage Divider With Low Output Impedance

A variable-ratio transformer is now being manufactured that can be used as an electro-mechanical transducer in servo systems and analog computers. It is essentially a combination of potentiometer and auto-transformer, but its inherent principle of operation is said to be radically different.

The device consists of a tapped auto-transformer which provides the basic division of voltage into several discrete levels. These levels are selected and further sub-divided by a continuous one-turn interpolating potentiometer. This is connected sequentially across sections of the auto-transformer in synchronism with movement of the potentiometer arm or wiper so that the voltage of the wiper is varied smoothly from one level to another throughout the entire range of voltage supplied by the auto-transformer. The potentiometer moving through ten turns interpolates between 30 transformer taps. The taps may be adjusted to approximate a curve of any nature.

This operating principle is said to

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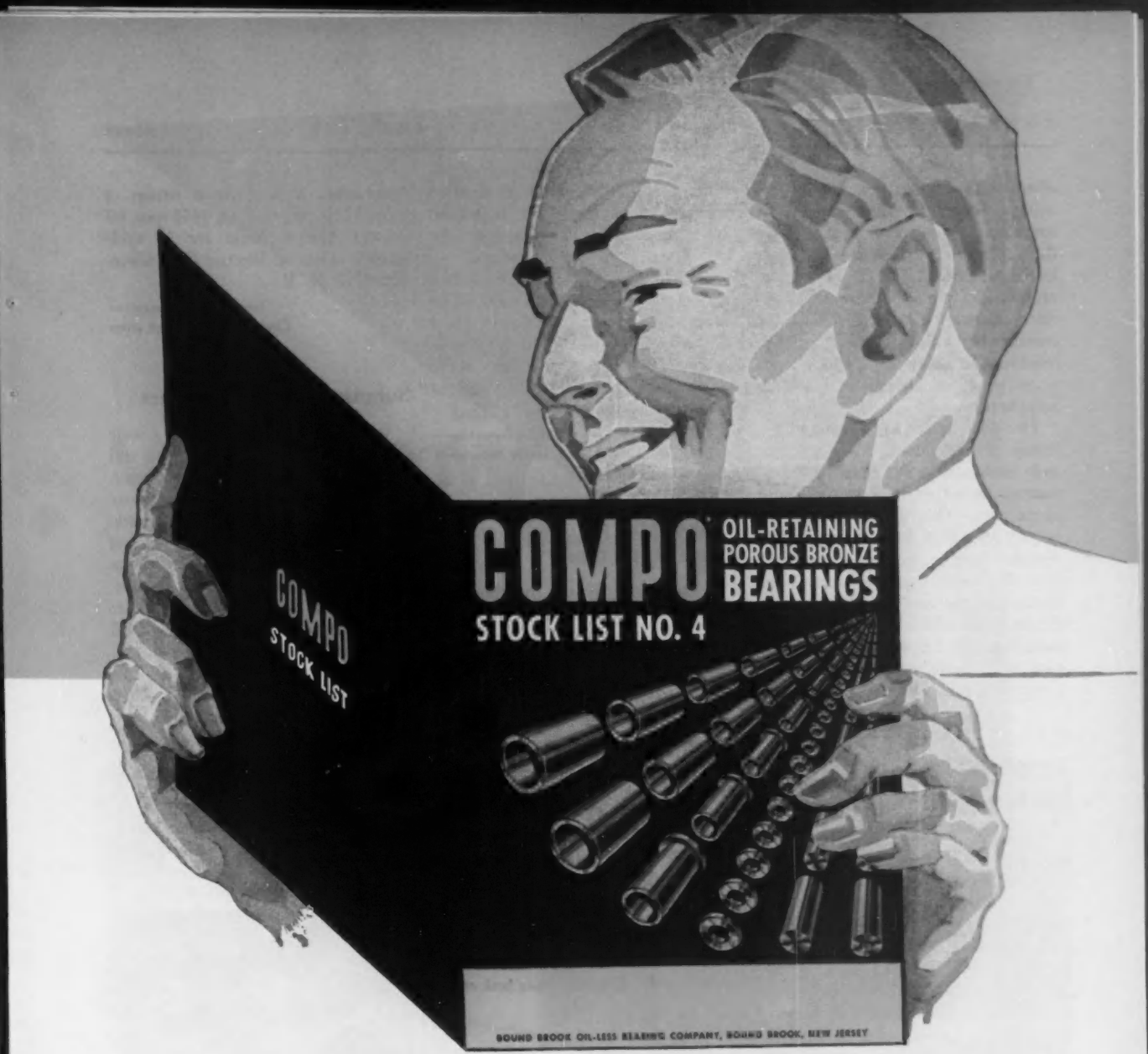

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offer several advantages. The new voltage divider is unique in that it combines low output impedance with the resolution and linearity ordinarily associated only with high impedance, multi-turn potentiometers. Total electrical rotation is held to close tolerances eliminating the need for trim resistors. In many applications there is no need for impedance matching amplifiers.

The pilot model has a linearity tolerance of better than ±0.05 percent and resolution better than 0.01 percent at an output impedance of 130 ohms max. This design permits an output current of 50 milliamperes. It operates over a frequency range of from 50 to 3000 cycles per sec. Other versions of the new device are under development which included a minaturized model for 400 cycles per sec and a 60 cycle unit. Perkin-Elmer Corp., Norwalk, Conn.

For more information—
Circle 48, inside back cover

Enclosed Wiring Trough

Electrical wiring troughs that comply with JIC specifications are oil, dust and watertight. Standard sizes include one model that is 2½ in. square, in lengths of 12, 13, 24 and 36 in., made of 16 gage steel. Another is 4 in. square in lengths of 18, 30, 40 and 72 in., made of 14 gage steel.

The cover is equipped with a neoprene sponge gasket and is fastened to the trough by external hinges and clamps. There are no conduit knockouts or holes. The seams are gas welded. The trough is mounted or supported by external mounting feet. Hoffman Engineering Corp., 1078 Tyler St., Anoka, Minn.

For more information—
Circle 49, inside back cover

Miniature A-c Generator

A permanent magnet generator, for indicating the position of a rotating shaft by providing two voltages, one the sine of the shaft position, the other the cosine, can operate up to 6000 rpm with a maximum harmonic content of 3 percent. It is built to military specifications for high and low temperature operation and contains stainless steel ball bearings.

The generator is available in two sizes, 1.43 in. and 1.67 in. dia. The larger size can be provided with a seal at the terminal block end for use in hermetically sealed assemblies. Beckman Instruments, Inc., 220 Pasadena Ave., S. Pasadena, Calif.

For more information—
Circle 50, inside back cover

Thermostat for Small Appliances

A thermostat for use in vaporizers, percolators, dryers and other table appliances has a bimetal thermal element that is current-carrying. It is said to be particularly well-suited for appliance applications where an inexpensive unit is required and where heat due to passage of current through the bimetal is either not objectionable or is perhaps desirable.

Contacts are Monel-backed silver. While contact spring is normally made from stainless steel, both this material and the bimetal alloy may be changed to meet certain specific conditions. Stevens Mfg. Co., Inc., Mansfield and Lexington, Ohio.

For more information—
Circle 51, inside back cover

Totally Enclosed, Fan-Cooled Fhp Motor

Smaller and a third lighter than previous designs according to the manufacturer, this fhp motor was designed especially for driving light machine tools and materials handling systems. Large-size ball-bearings absorb heavy thrust loads and are said to require no lubrication for ten years of normal service.

The new motor has a large, built-in terminal board and easily accessible base slots for simplified installation. Mounting dimensions of the new motor are the same as for standard open motors of the same rating.

In NEMA 48 and 56 frames, the new motor is available in ratings of ⅛ hp, 1140 rpm, to ⅓ hp, 3450 rpm, 60 cycles. Also available are 50 cycle models. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 52, inside back cover

Subminiature Delay Lines

In each of the three series, a wide range of characteristic impedances and delay times is offered. The basic difference lies in their relative complexity of construction (or number of sections). The V Series has the largest number of sections, and hence the largest ratio of delay time to rise time. The U Series has a somewhat simpler and more compact construction, and the T Series is the smallest and simplest of all.

The range of delay times covered by this maker's delay lines has been extended by these new items from 2.5 to 0.1 microsecond. A 3.0 microsecond line has also been added. Jacobs Instrument Co., Bethesda 14, Md.

For more information—
Circle 53, inside back cover

Step Starter For Large Home Air Conditioners

According to the manufacturer, this starter breaks the starting voltage drop into two steps, reducing light flicker that usually occurs when air conditioners are turned on.

The step starter for units of 3 to 5 hp inserts a resistance in series with the motor for approximately 2 sec. After that, the timing relay energizes the coil of the contactor, shortening

CONTINUED ON PAGE 242

Here's Terrific NEWS IN HYDRAULIC PACKING!

LINEAR VEE-DAM RINGS

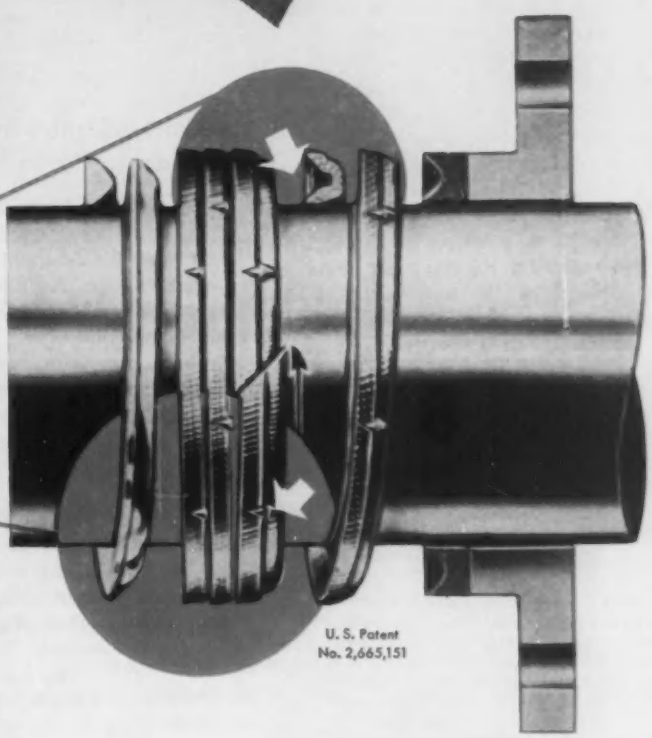
Unique, new and revolutionary design of LINEAR VEE-DAM Rings now does what no other packing has ever done: It completely eliminates labyrinth leakage, regardless of the fit at the ring joints. Even when gaps occur, through careless installation, or from variations in bore size, fluid can't leak past LINEAR VEE-DAM Rings!

STURDY RUBBER DAMS

in the grooved hinge area of each ring hermetically seal off center groove sections when rings are stacked together . . . eliminate all labyrinth flow.

EXTERNAL ABUTMENTS

on the shoulders of each ring prevent lateral leakage and provide stabilizing support.



U. S. Patent No. 2,665,151

LINEAR VEE-DAM Rings save on installation and maintenance . . . reduce down time. They last longer, work better! We're molding them in a variety of sizes and compounds. Let us show you how VEE-DAM Rings can solve your packing problems!

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

the resistor and applying full voltage to the motor. This reduces the current on the first step and reduces the initial voltage drop which causes light flicker. When the resistor is shorted out, a second increase in current results to start the motor, but decreases as the motor gains speed. General Electric Co., Schenectady 5, N. Y.

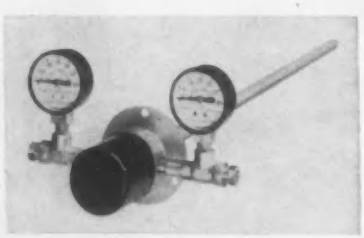
For more information—
Circle 54, inside back cover

Instantly Reverses Condenser Motor

Single-phase, condenser-start type electric motors up to 2 hp can be instantly and positively reversed with this reversing switch. It is reported that the device eliminates the need for expensive special motors or special wiring circuits, now employed by manufacturers of lathes, conveyors, hoists.

A special circuit and momentary contact pole in this switch, which is connected to the condenser motor centrifugal switch, accomplishes instant reversing of the motor shaft when the drum switch is operated. The instant reversing is no harder on the motor winding than a normal motor start. The switch can be used to reverse polyphase motors up to 2 hp and ¼ hp d-c motors. Gayston Corp. 1226 Ray St., Dayton, Ohio.

For more information—
Circle 55, inside back cover



Non-Bleed Pneumatic Temperature Control

A pneumatic temperature control, said to be inexpensive, is now available for operation of such devices as diaphragm valves, damper motors and other types of control equipment. It is a differential expansion type control designed for regulation of heating, cooling, ventilating, air conditioning, dew point control and industrial processes.

Temperature range is from 35 to 135 F. The concealed graduated dial permits quick, easy adjustment. Sensitivity can be adjusted from ⅛ to 2 psi per 1 deg temperature change.

Body is 1¾ in. OD and average bulb length is 18 in. with ¾ in. pipe or flange connection. Available with direct action only. Passage of air pressure is increased as temperature rises. Powers Regulator Co., Dept. PEN, Skokie, Ill.

For more information—
Circle 56, inside back cover

Servo Multiplier for Automatic Control

This multiplier operates from the 60 cycles per sec. line. Its basic action is to convert a d-c input variable into a shaft rotation. A precision potentiometer, driven by this shaft, performs the computation.

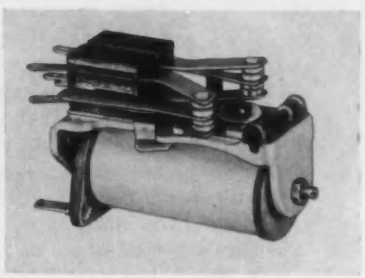
Three 2-megohm summing inputs are provided to accommodate one, two or three input variables. Overall accuracy is 0.3 percent, full scale travel under 0.5 sec. Response extends to 10 cycles per sec, and input zero drift is negligible. The multiplier is supplied either as two or three basic packages, or built into a standard 19 in. rack panel. Output indication is provided when required. Industrial Control Co., Wayandanch, L. I., N. Y.

For more information—
Circle 57, inside back cover

Vertical Subminiature Tube Holders

For application in printed circuitry and similar limited-space conditions where it is necessary to hold tubes and components securely against shock and vibration, these tube holders will hold up to 5 G vibration at 500 cycles. They are made in the basic component-holder cross-section with a mounting tab at right angles to the axis of the component, and are available for 0.375 and 0.500 in. dia. The new tube holders are made of iridite-dipped, cadmium-plated spring steel for military use or commercial finish for general industrial use. Atlas E-E Corp., Bedford Airport, Bedford, Mass.

For more information—
Circle 58, inside back cover



Sensitive Power Relay

A power relay which is reported to be as sensitive and accurate as a telephone-type relay has handled inrush currents of 50 amp for 50,000 operations with a rating of 10 amp, 27½ v, dc. It has exceeded 500,000 operations on motor load of 6 amp, inrush current of 15 amp, at 70,000 ft altitude.

Stability of the relay is increased by use of a hinge-type armature. A new heavy-duty yoke has a stainless steel pivot pin with a large bearing surface which turns in precisely reamed bearings of non-ferrous metal.

Nominal rating of the Type J relay is: 10 amp, 115 v, ac (resistive); 10 amp, 27½ v, dc. The relay is 2¼ in. long, 1⅛ in. wide and 1¾ in. high. C. P. Clare & Co., 4101 W. Pratt Blvd., Chicago 45, Ill.

For more information—
Circle 59, inside back cover

Five Digit Voltmeter

The Model 519 digital voltmeter is a self-balancing, digital potentiometer for measuring direct current voltages from 0.001 to 999.99 v. Maximum error is said to be either less than

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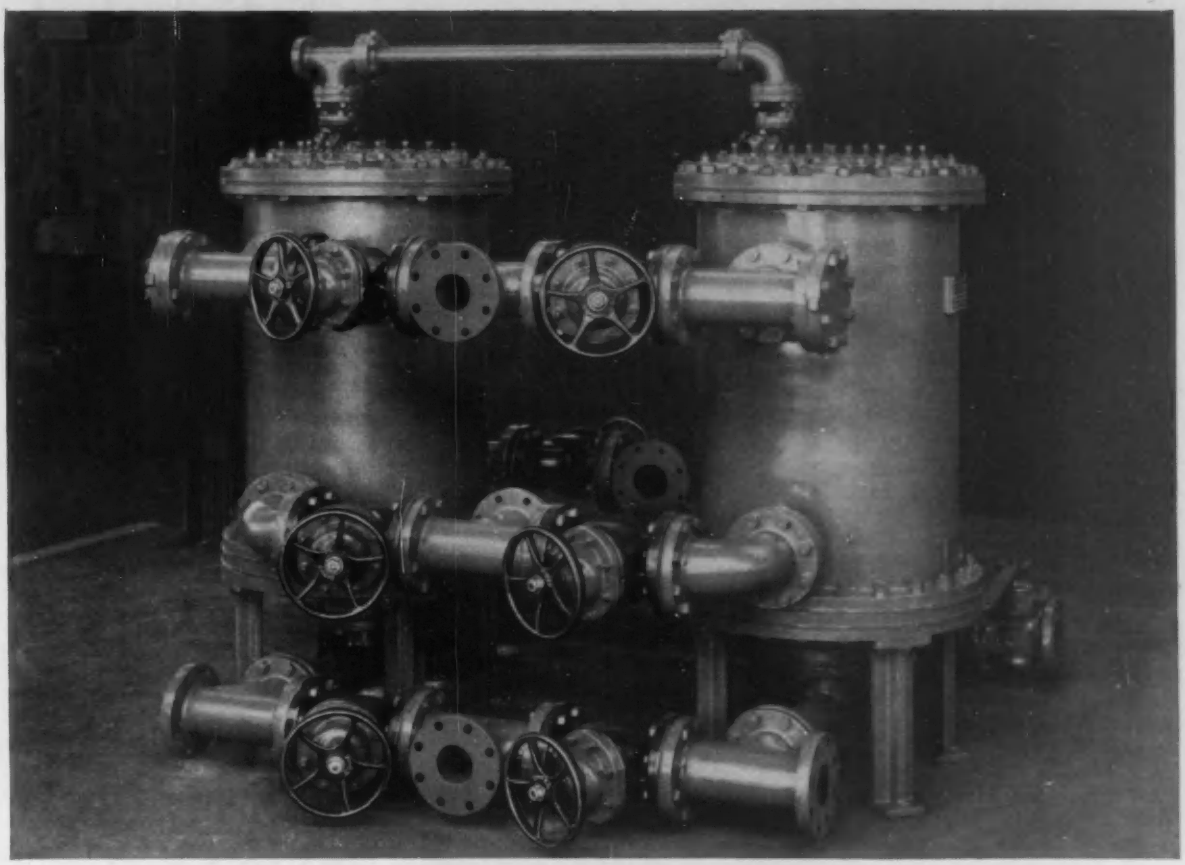
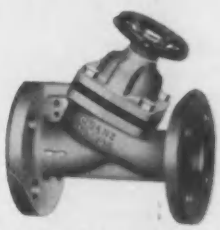


Another good product design with the Crane "label"

Several years ago a southwest chemical plant was plagued by sand clogging their spent brine disposal wells. To correct the condition, the R. P. Adams Company, Inc., of Buffalo, N. Y., installed two CRF-5 rubber-lined filters with rubber-lined Crane Y-pattern diaphragm valves and rubber-lined fittings and pipe. The trouble-free service of the original units in handling this corrosive fluid was the contributing factor in the recent purchase of two additional and identical filters.



Crane Y-Pattern Diaphragm Valves . . . preferred for safety and versatility. Crane design assures long diaphragm life, positive shut-off in case of diaphragm failure, accurate seating, better flow control. Easy to operate . . . simple to maintain. Choice of body, trim and lining materials. Screwed and flanged end patterns. Sizes up to 6 inch.

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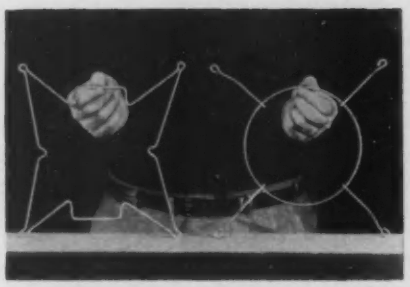
"Simplicate it... and add more Lightness"

This famous saying by one of America's leading research engineers is the key to much of today's design progress. Sometimes all it takes is the right twist—in Wire. Here are a few specific examples from "Wire Goods Headquarters" . . .

This simple twist saved $1,530.00 in one year

Manufacturer's wire motor mount design called for 26 bends in a 28"-long wire . . . almost impossible to hold tolerances. Titchener suggested simplified design at right: a ring, 4 support wires, 4 welds—that's all. Estimated saving 10.2c per piece.

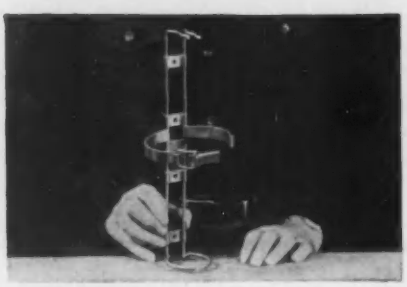


This simple twist saved 75¢ per unit

By combining a motor mount and fan guard in one wire-and-strip assembly, Titchener eliminated expensive pipe frame-work and heavy stampings, reduced noise level, and saved 75c per unit over the former design.

This simple twist cut weight in half

Extinguisher wall bracket redesigned by Titchener eliminates 16 rivets and 3 stampings. Improved design is stronger, more serviceable—weighs half as much—gives substantial savings in manufacturing and material costs.



Wire construction and design assistance by Titchener may be able to solve your cost problem, whatever your product. Our engineers will be glad to help you find out. Merely send prints or samples. No cost or obligation for our analysis and recommendations.

Free Case History Booklet. Shows before-and-after illustrations of 36 products and parts which have been redesigned in wire. Gives specific cost savings and product improvements accomplished. This booklet can be a storehouse of tips and ideas for design and purchasing men.

WIRE GOODS Headquarters

E.H. Titchener & Co.

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0.01 percent of the applied voltage or 00.001 v, whichever is greater. This instrument makes an average of 75 readings a minute, with automatic indication of polarity and decimal position. Input resistance is on the order of 1000 megohms on the low range (up to 99.999 v) and 11 megohms on the high range (100.00 to 999.99 v).

The front panel readout presents an internally-lighted, in-line numerical display of the digital information, polarity and decimal. Accessories are available for transmitting this information to remote readouts, as well as for printing, typing or punching permanent records. Dimensions are: width 19 in., height, 8¾ in. for standard instrument (or 10½ in. if buffer relays for printing are required); depth, 14⅛ in. Weight is 49 lb for the standard instrument. The instrument is designed for 115 v, 60 cycle operation. Non-Linear Systems, Inc., Box 728, Del Mar, Calif.

For more information—Circle 60, inside back cover

Fuse and Resistor Clips

Navy type fuse and resistor clips that provide positive locking under extreme conditions of shock and vibration consist of silver-plated, phosphor bronze clasps and passivated stainless steel springs. An ejector is said to make resistor and fuse changing an easy matter. They are available in three ferrule diameter sizes, three different lug lengths, and can be obtained with ejector or non-ejector springs. Raytheon Mfg. Co., Waltham, Mass.

For more information—Circle 61, inside back cover

High Temperature Rectifier

A selenium rectifier, intended for operation at temperatures substantially above the limits of conventional units, is said to have operated satisfactorily in ambient temperatures up to 100 C. The rectifier will operate continuously at the same normal full-rated loads as at lower temperatures. With a moderate amount of derating, the new rectifier will operate in temperatures up to 150 C.

As a result of this development, the

connections simplified

For low level sound applications.

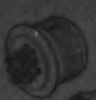
Breakaway connector for instrument testing and control circuitry of guided missiles prior to launching.

For aircraft engine starting, commercial storage batteries, and stationary engine applications.

Sub-miniatures. Same number of contacts as in a standard connector, but in ¼ to ⅓ the space.

Miniatures.
For radio, control, instrument uses, etc.

General service
and unit plug-in types



Hermetically sealed AN and K type connectors. Miniatures and sub-miniatures.

Socket K connectors for TV cameras.

Water-tight and weather-proof connectors for rugged service.

Heavy-duty AO type, originally designed for U.S. Army Ordnance. Adaptable to commercial use. Resilient insulation. Special assemblies.

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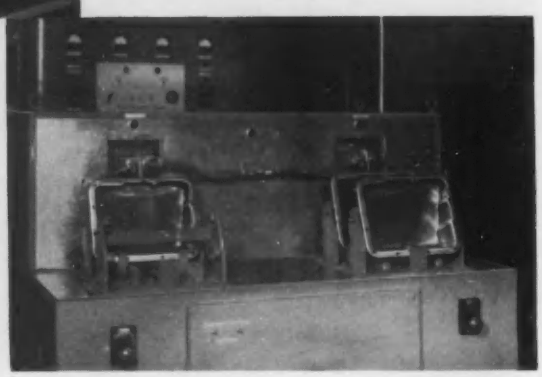
BIASTRE

A prize recipe FOR BRAZING SPUDS

The principal ingredient is the low-temperature silver brazing alloy EASY-FLO. You simply place the spud in position with a ring of EASY-FLO wire around it, apply flux and heat. Logan Machine & Metal Stamping Co., Akron, Ohio, get excellent results with this recipe in brazing spuds in the oil pans that are part of an automatic automobile drive. Photos show how they do it.

Pans with spuds and EASY-FLO rings are placed in fixtures of 2-station induction heating unit. Brazing two at a time, production is 400 an hour. Under a 100-lb. torque test "the pan pulls apart first."



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manufacturer states, selenium rectifiers can now be used in locations where their use has been impossible previously because of temperature limitations. Also, it is now possible to obtain desired d-c output in high temperature locations with smaller, more compact rectifiers.

The rectifier is available in all standard cell sizes and circuit arrangements. Fansteel Metallurgical Corp., N. Chicago, Ill.

For more information—
Circle 62, inside back cover

Bushing for Electrical Connections

A ½ in. bushing for electrical connections, said to allow easier installation, has a flared skirt for easier starting and deep-cut threads which permit maximum tightening with the fingers. The new bushing has prominent raised lugs for final setting with a screwdriver. A smooth curled throat protects wire insulation from cutting or abrasion. National Electric Products Corp., Gateway Center, Pittsburgh, Pa.

For more information—
Circle 63, inside back cover

Smallest Printed Circuit Connector

Weighing less than eight-tenths of a gram (about 1/40 oz) and less than 0.03 cu in. in volume, this connector is a four-contact subminiature female unit for use with a ⅛ in. printed circuit or for conventional cabling applications. This connector mounts with a standard No. 0 machine screw. Circon Component Co., 17544 Raymer St., Northridge, Calif.

For more information—
Circle 64, inside back cover

Transducers With 0.003 to 2 in. Ranges

Linear motion displacement transducers are now available in thirty-two models with of 0.003 to 2 in. Operation of these units is based on the linear change in flux linkage between the primary coil and secondary coils with displacement of the high-per-

meability metal core. Displacement of the core in either direction from the center null position causes a linear increase in output voltage. Units are inductively and resistively balanced for minimum null signals. All models may be obtained magnetically shielded or wound for high temperature operation.

The physical size of the new transducers ranges from $\frac{1}{4}$ in. OD by $\frac{1}{4}$ in. long for the 0.003 in. linear displacement unit to $\frac{3}{4}$ in. OD by $9\frac{1}{2}$ in. long for the 2 in. linear displacement unit. Minatron Corp., 10 Cliveden Place, Belle Mead, N. J.

For more information—
Circle 65, inside back cover

Wirewound Control Of 1-$\frac{1}{8}$ In.

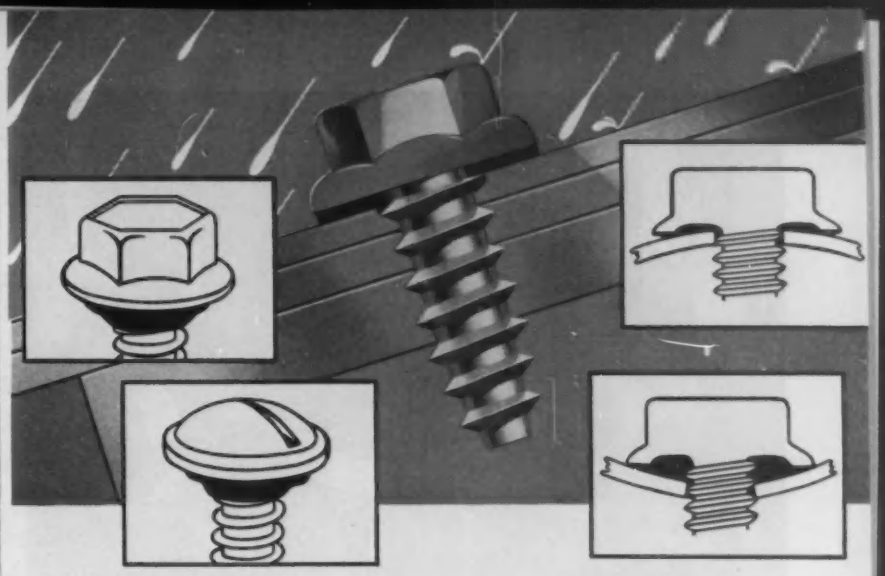
This control is distinguished from the manufacturer's previous design by an improved wiper arm that contacts the edge rather than the side of the resistance winding. This is asserted to allow higher resolution, more intricate tapers and closer tolerances in overall resistance and linearity. End termination is greatly improved in that terminals are directly fastened to winding, insuring low contact resistance. Collector and terminal are now in one piece, eliminating rivets as mechanical fasteners and current conductors. Stop is integral with base instead of in the cover, insuring a more positive stop, and leaving no holes in cover for dust, moisture, oil to enter.

Series 43c is available in standard ohmages from 1 to 50 k, with electrical tolerance of ± 5 percent, and independent linearity to ± 2 percent. It is rated at 2 w. Taps and various tapers are available. Clarostat Mfg. Co., Inc., Dover, N. H.

For more information—
Circle 66, inside back cover

Differential Transformer Amplifier

Static, transient, or higher frequency oscillatory physical phenomena, including, force, pressure, stress, strain, acceleration and displacement, can be studied and measured using the Model 400 amplifier in conjunction with available differential trans-



New *Tuff-Tite Fastener Prevents Leaks—**
Protects Surface—Absorbs Shock—Stops Squeaks

Tuff-Tite is a new multi-purpose fastener with a one-piece metal head and assembled neoprene washer that gives you quick, secure, economical, leakproof fastening of metals and plastics.

Use of Townsend's Tuff-Tite makes possible watertight fastening of galvanized steel, protected metal, stainless steel, aluminum, plastic and other roofing and siding materials at substantial savings over conventional fasteners.

Leaks between the head of the screw and the metal washer are impossible because they are made as one piece. When this fastener is tightened, the pre-assembled neoprene washer is trapped and controlled by an undercut in the washer head. The neoprene is forced into the hole and around the threads to form a watertight and airtight seal.

Tuff-Tite fasteners provide surface protection in assembly of appliances and similar products. The neoprene washer provides a cushion that permits tight seating without cracking or chipping porcelain enamel and other fine finishes.

Where vibration noise is a problem in automobiles, railroad passenger cars and machinery, the cast neoprene washer on Tuff-Tite fasteners acts as a shock absorber—eliminates squeaks and chatter.

Tuff-Tite fasteners are available as self-tapping screws, thread cutting screws, drive screws, machine screws, stove bolts, wood screws, nails and special products. They are made of carbon, alloy and stainless steel, aluminum, copper and other metals in a variety of head styles.

To learn more about how Tuff-Tite can increase your fastening efficiency—improve your products, use the coupon below or write.

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former transducers. The unit includes a carrier oscillator, demodulator and all circuits necessary to provide an output suitable for display or photographing on a cathode ray oscillograph. Low impedance output for galvanometer oscillographs is optionally available.

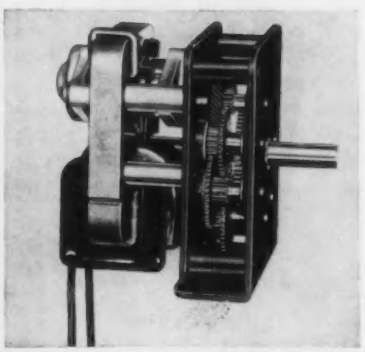
Stable calibration, overall linearity exceeding 1 percent and flat frequency response from zero to 1000 cycles per sec within ½ db are said to be characteristic of this new device. Transducer core displacements as small as 0.001 in. can be measured. Daytronic Corp., 216 S. Main St., Dayton 2, Ohio.

For more information—
Circle 67, inside back cover

Miniature 3-w Resistors

This resistor is the same size as conventional ½ w molded carbon resistors. Developed especially for use in military and industrial electronic equipment, this unit is expected to find application in point-to-point and terminal board wiring as well as on printed wiring boards. It is 11/64 in. dia, 33/64 in. long and has a maximum resistance value of 10,000 ohm. Sprague Electric Co., 195 Marshall St., N. Adams, Mass.

For more information—
Circle 68, inside back cover



Gear Train and Motor

This gearmotor is said to be adaptable to business machines, appliances, vending machines. It can be had in a selection of torques ranging from 60 in.-lb at 1 rpm to 50 in.-lb at 10 rpm (1/300 to 1/35 hp) and in any single speed from ¼ to 426 rpm, operating

Do these
5 NEW ASCO SOLENOID VALVES
meet a special need for you?

Five completely new solenoid valves were developed by ASCO during 1954. Smaller size, greater efficiency and longer reliable life fit these valves to specific industrial uses.

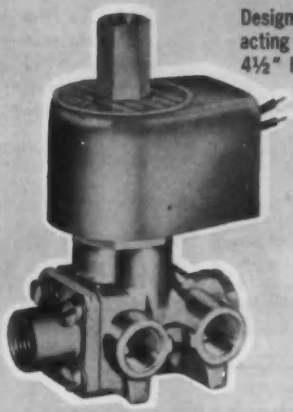
A NEW ASCO 2-WAY SOLENOID VALVE

COMPACT: Only 2¾" face to face; 3 13/16" overall height.

Simple: Just two operating parts. Can be mounted in any position. Low power consumption. Standard, explosion proof or watertight solenoid enclosures. Normally open or normally closed.

BULLETIN 8210A

A NEW ASCO 4-WAY MIDGET SOLENOID VALVE



Designed for control of small double acting cylinders. Compact: Under 4½" high, 2" wide, 2" deep with standard NEMA I solenoid enclosure. Operates up to 400 cycles per minute mounted in any position. Standard, explosion proof or watertight solenoid enclosures.

BULLETIN 8345

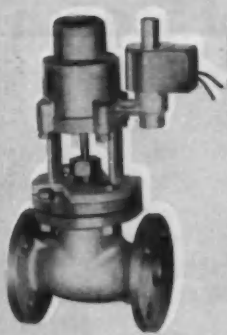
A NEW ASCO SOLENOID PILOT CONTROL VALVE WITH SAUNDERS PATENT TYPE BODY

Absolutely tight shut-off control for corrosive liquids and gases. The dependable ASCO pilot provides automatic control of main diaphragm valve using auxiliary pressure. Available normally open or normally closed in a wide selection of body materials. Standard, explosion proof or watertight solenoid enclosures.

SPECIAL BULLETIN 8336

A NEW ASCO CORROSION RESISTANT, CYLINDER OPERATED 2-WAY VALVE

BULLETIN 8338



Two valves designed specifically for processing plants where corroding liquids or gases are handled. Many types of body materials available. Standard, explosion proof or watertight solenoid enclosures.

A NEW ASCO CORROSION RESISTANT 3-WAY SOLENOID VALVE

SPECIAL BULLETIN 8300

ASCO Electro-Magnetic CONTROLS

ASCO Solenoid VALVES

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Practically non-breakable, Durakool **Pre-set Timer Relays** have more than proved themselves on the roughest and toughest jobs that could be found. Year by year, their use increases in sensational fashion.
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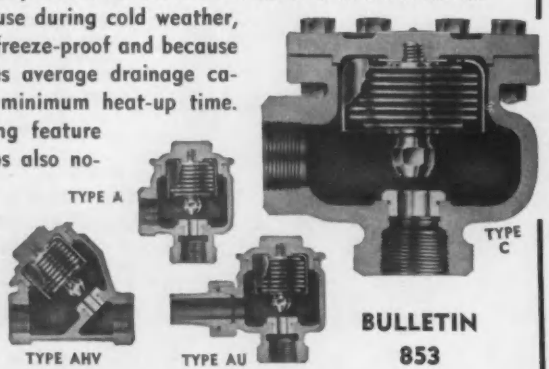
Freeze-Proof Steam Traps

for every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Types for every plant use. Size ¼" to 2"; pressures to 300 lbs.



BULLETIN 853

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TRAPS · VALVES · FLOATS

either clockwise or counter-clockwise as specified.

Gears, pinions and shafts are all hardened steel. Bearings are bronze and lubrication is provided by a large felt oil reservoir. Provisions are made for either base or panel mounting. The shaded pole motor operates on 115 v, 60 cycle, a-c current, with die-cast bearing brackets, internal cooling fan and self-aligning oil-less bearings. New England Gear Works, 2013 S. End Road, Southington, Conn.

For more information—
Circle 69, inside back cover

Servo Amplifier For 400 Cycles Per Sec

This amplifier is said to provide sensitivity and power output available before only in much larger designs. Maximum height is 4 in., maximum width 2⅜ in. and maximum depth is 1¼ in. Weight is 6.6 oz.

Designed to deliver 4 w into the control phase of a servo motor, the new amplifier's condensers balance off the reactive component of the motor load. The gain of the amplifier may be varied externally. The complete amplifier is encapsulated in epoxy resin in order to minimize the effects of moisture, vibration and other adverse environmental conditions. Capable of continuous operation at 85 C ambient temperature, the VA-4-A-60 will withstand temperatures up to 125 C. Clifton Precision Products Co., Inc., Maple at Broadway, Clifton Heights, Pa.

For more information—
Circle 70, inside back cover

Small-Size, High Output Amplifier

A modulator-amplifier with fractional-watt input and 100-w output, yet small enough for use in miniaturization programs, will accept a-c, d-c and phase-shift error or control signals as low as 50 millivolts, sensing their phase or directions, and supplying output power at a gain of 300 to 1000 absolute value. The unit occupies only 12 cu in. volume and weighs 1 lb.

It is used with actuators, and it is reported that it can be used to set up simple durable control or servo sys-

tems. In these uses, the basic system does not require anti-hunt feedback. The unit is on a power supply with a frequency range of 200 to 800 cycles per sec. Units of 60 cycles are also supplied. Loads may be resistive or inductive. The unit acts as a relay with no moving contact points, since no power is supplied the load in the null or standby condition. Output to load is a good sine wave. Standard Plastics and Electronics Co., 1540 S. Robertson Blvd., Los Angeles 35, Calif.

For more information—
Circle 71, inside back cover

Ceramic Switches

Oval ceramic switches that are said to combine the versatility and adaptability of radio-type switches with the heavy-duty construction of instrument-type switches are available in shorting types with either 20 or 30 deg indexing or in non-shorting types with 40 or 60 deg indexing. These Series 12000 switches may be assembled with up to three poles per deck and with up to 10 decks per switch. All types are available with star-wheel detent mechanism and adjustable stops.

Low contact resistance, only 0.0025 ohm, is achieved through the use of ¼ in. dia silver contact, silver collector rings and silver wiper arm contacts. Nominal rating is 1 amp, 110 v, 60 cycles. At lower currents, or where current is not broken, these switches will handle up to 2500 v, 60 cycles; at lower voltages—currents up to 40 amp. Shallcross Mfg. Co., Collingdale, Pa.

For more information—
Circle 72, inside back cover

Motor-Tachometer Combinations

These d-c motor, d-c tachometer combinations measure 2⅜ in. dia by up to 5½ in. in length. All combinations are supplied with auto-reset thermal overload protectors built into the motors. Capacitor filters for both motor and generator are available.

The new line includes units with standard motor outputs of 5 to 100 w for speeds to 10,000 rpm, with an

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Model 2AM Air Motor used by Paasche Air Brush Company as standard equipment for driving agitator paddles on industrial material supply tanks.

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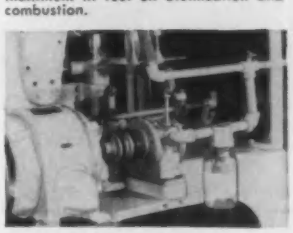
Models 1065 and 2065 Rotary Compressors are used on York-Shipley "Steam-Pak" Boilers to insure the maximum in fuel oil atomization and combustion.



Model 1550 Vacuum Pump is used on Stokes & Smith paper box wrapping machine to automatically pick up the sheets of covering paper.

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...100 to 6,000 r.p.m.

COMPRESSORS
...up to 30 p.s.i.
...1/2 to 24 c.f.m.

VACUUM PUMPS
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...1/2 to 24 c.f.m.

To help spark new ideas for you, this new "APPLICATION IDEAS" booklet is packed with practical applications currently used on production models of customers' machines. On each page it gives details about the uses of Gast rotary air motors, compressors and vacuum pumps. WRITE FOR YOUR FREE COPY NOW.

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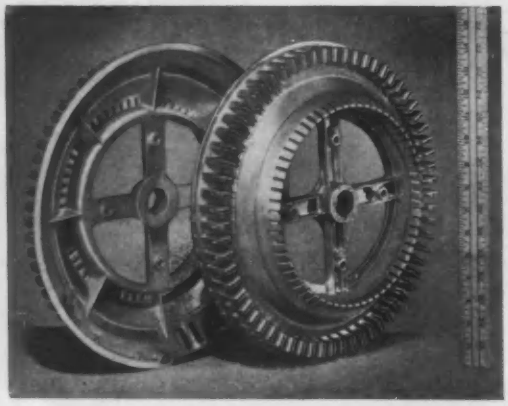

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operating voltage range of 6 to 220 v. Both permanent magnet and wound-field types are available, and units for any combination of field and armature voltages can be supplied.

Standard tachometer output is 6 v per 1000 rpm, ± 10 percent. Units with other voltage gradients can also be specified. Linearity of all units is guaranteed within less than ± 1 percent and maximum ripple, 4 percent or less, without filtering. Electric Indicator Co., Inc., Springdale, Conn.

For more information—
Circle 73, inside back cover

Miniature D-c Motor

This permanent magnet motor is 2.8 in. long. Weight of the motor is 4½ oz.

Specially designed for timing equipment and other applications requiring constant speed under continuous use, the new d-c motor is said to meet or exceed all applicable requirements of AN-M-40. It may be designed for any input voltage from 6 to 30 v, dc, has an output of 6 w max for continuous duty or 12 w max for intermittent duty. The output of the motor can be designed for any speed from ½ to 9,000 rpm, depending on the gearing installed.

The new product has an aluminum alloy case with plastic molded brush housing. The ball bearings are sealed and greased for the life of the motor. El Ray Motor Co., N. Hollywood, Calif.

For more information—
Circle 74, inside back cover

Fuse Cutout Has All Available Operating Functions

The flexibility of these enclosed cutouts is accomplished with one housing and four interchangeable doors in each voltage and current rating, the manufacturer states. The choice of doors provide for normal duty indicating or dropout, normal duty indicating non-dropout, indicating heavy duty or extra-heavy duty, and disconnect functions.

The new unit's broad-faced, high-pressure V-wedge contacts are free-floating, self-aligning and self-wiping,

to assure low contact resistance and better alignment. Compression clamping of the mounting support to the porcelain housing is provided for maximum mechanical strength.

The new cutouts, which help provide distribution system and apparatus protection against short circuits and overloads, are currently available in voltage ratings of 5.2 and 7.8 kv, in continuous current ratings of 50 amp and in all applicable NEMA standard interrupting current ratings. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 75, inside back cover

Rerated Explosionproof Motor

Available in ratings of 1 to 5 hp, these NEMA rerated motors were designed for use in classified atmospheres containing flammable gases or combustible dusts. The end shields are fastened to the frame with external bolts to avoid a flame path to the interior of the motor. The cooling fan is made of a special plastic so that there will be no danger of the fan striking a spark. Due to the extra weight of these heavy-duty motors, a lifting ring is provided in all frame sizes. General Electric Co., Schenectady 5, N. Y.

For more information—
Circle 76, inside back cover

Miniature Electric Motors

Miniature motors for use in actuators or other high speed applications have been announced. Motor No. 452008 is a split series type, 24 v, dc, or 110 v, ac, rated at 2.5 in.-oz for intermittent duty to 160 F. The motor is available for single direction or reversible operation and can be supplied with or without integral filter. Weight is 13 oz and the overall dimensions are 3x3x2½ in.

Motor No. 1007690, designed to specifications AN-N-40 and MIL-E-5272, is rated at 4 in.-oz torque, intermittent duty to 165F. This is a split series, 24 v, dc motor. It is available for single direction or reversible operation, with or without a magnetic brake. Size is 1 in. square by 2 in. long. The model is also manufactured

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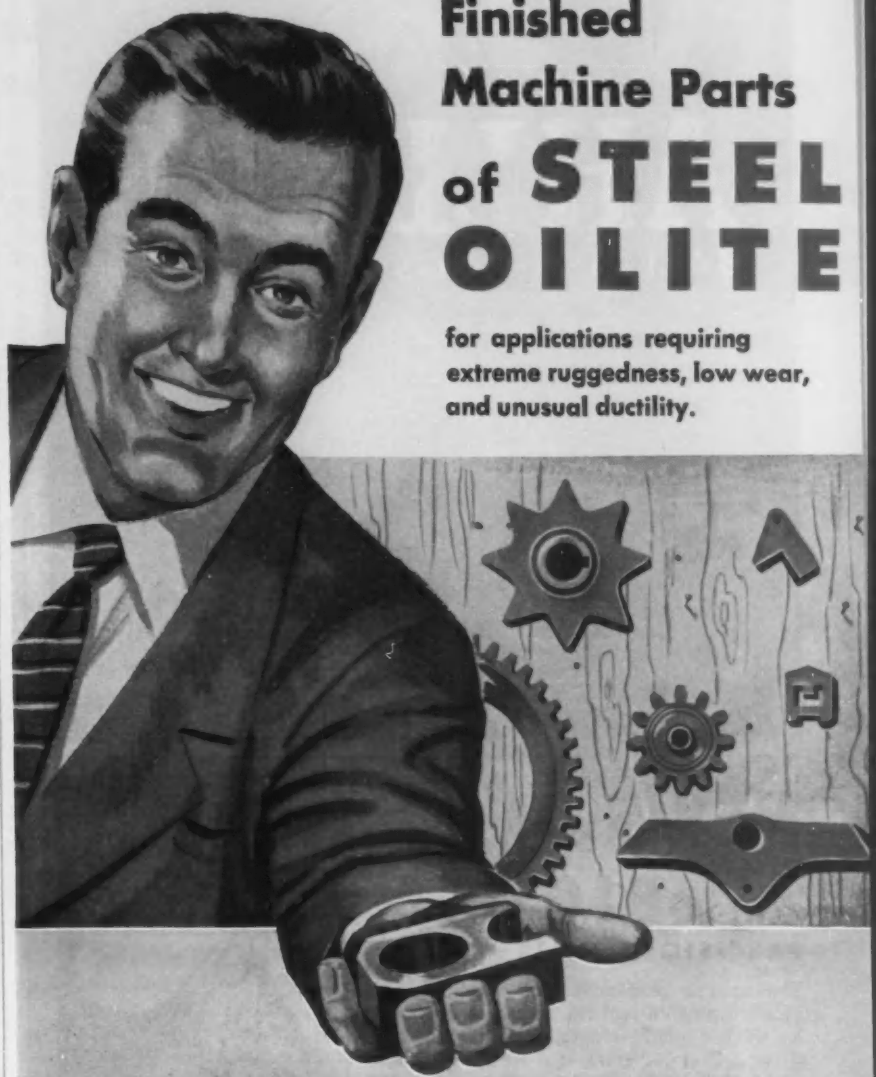
for applications requiring extreme ruggedness, low wear, and unusual ductility.



If you've passed up using metal powder finished machine parts because your applications require units of greater strength and ductility than they normally provide, then you will want to investigate STEEL OILITE.

Here is a new, yet thoroughly proved, metal powder product that is saving users from 35% to as high as 96% over conventionally produced precision finished machine parts.

STEEL OILITE Finished Machine Parts provide revolutionary new strength and ductility that makes these big savings practical on countless new applications where component parts need to be especially tough.

Write today for the New Bulletin on STEEL OILITE just published. It's yours for the asking. Please request Bulletin STM-54.

A CHRYSLER OILITE PRODUCT

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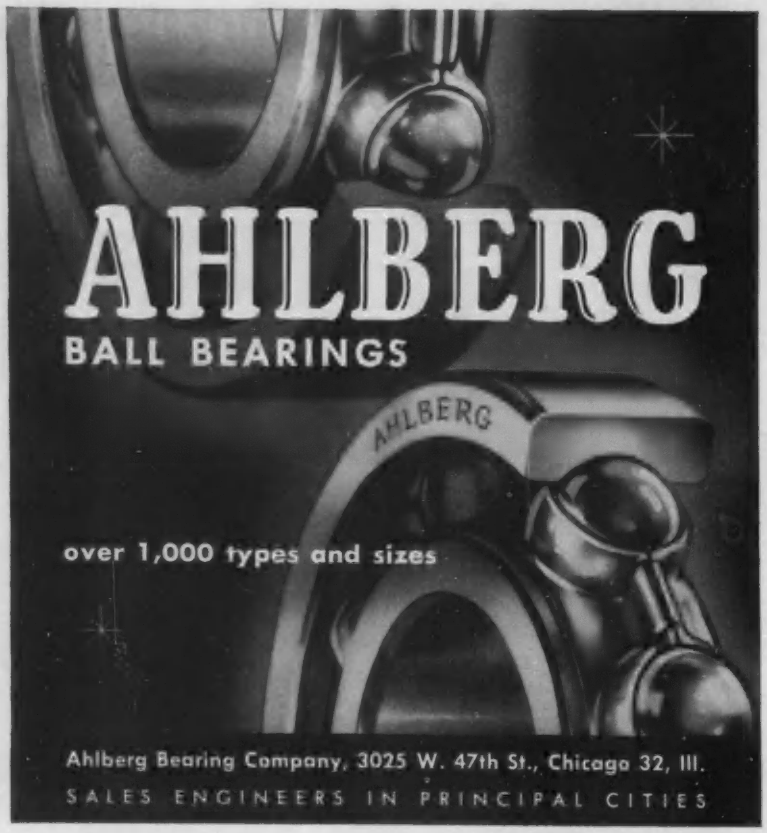
AMPLEX DIVISION
Dept. F-12 **Detroit 31, Mich.**

FIELD ENGINEERS THROUGHOUT THE UNITED STATES AND CANADA

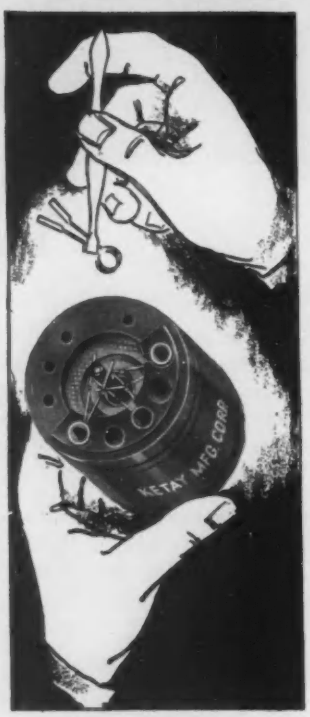
OILITE PRODUCTS INCLUDE: Bearings, Finished Machine Parts, Cored and Solid Bars, Permanent Filters and Special Units of Non-Ferrous and Ferrous Metals and Alloys including Stainless Steel.



NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS

The accurate transmission of electrical impulses through a movable contact is dependent solely upon the properties of that contact. Illustrated at the right is a Ketay Synchro, which is the heart of many precision indicating, communicating and control devices. Ketay is noted for Synchros and Resolvers capable of extreme accuracy. Therefore, Ney Precious Metal Contacts have been selected because of their practically ideal physical and electrical properties.

Ney Precious Metal Alloys have high resistance to tarnish, are unaffected by most industrial corrosive atmospheres, and are fabricated into slip rings, brushes, commutator segments, wipers, contacts and similar components for use in electrical instruments. Call on the Ney Engineering Department for help in selecting the right Ney Precious Metal Alloy which will improve and prolong the life and accuracy of your instruments.



THE J. M. NEY COMPANY
109 ELM STREET, HARTFORD 1, CONN.
Specialists in Precious Metal Metallurgy Since 1812

for use in ambient temperature up to 275 F.

A third motor, No. 406046, is a shunt field type, 24 v, dc for single direction service only. It is rated at 1 in.-oz for continuous duty to 160 F. The motor incorporates thermistors in the field to compensate for temperature effect on motor speed. Weight is 13 oz. Bendix Aviation Corp., N Hollywood, Calif

For more information—
Circle 77, inside back cover

Magnetic Clutch of 50 to 100 In.-Oz

For use in automatic control and other servo devices, the T500 has ball bearings throughout and its couplings are said to be designed so that they will not induce angular displacement error.

The new clutch is 1¾ x 2.062 in. and at 24 v, dc, engagement time is 3 milliseconds, power consumption 3 w. Various modifications of the standard design are available. Trans-American Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y.

For more information—
Circle 78, inside back cover

Sub-Miniature Transistor Transformer

Because of its compact design, this transformer is said to be suited to transistor circuitry in input, intermediate or output stages. The standard model has a primary impedance of 20,000 ohm, with a maximum direct current of 1 milliampere. The secondary impedance is 1,000 ohm. The dimensions of this unit are ⅜x⅜x⅜ in. Arka Imports, 904 San Pasqual St., Pasadena 5, Calif.

For more information—
Circle 79, inside back cover

Instrument Servo Motor

This motor has an integrally molded stator and housing. Liberal design characteristics are built-in so that long life can be expected even under severe ambient temperature conditions. The new servo component

is offered in two models with ratings of 1 and 5w. Locked torque is said to be 1.5 and 5.5 in.-oz, respectively.

If desired, the motor may be wound, at some additional cost, with high impedance control windings for operation directly from the plates of electron tubes. Of particular interest is the fact that the 1-w motor may be controlled with a maximum of 3 w, since most of the power required is applied to the reference phase. This results in further economies since the motor can be operated with a low-cost drive package. Diehl Mfg. Co., Somerville, N. J.

For more information—
Circle 80, inside back cover

Resistor With Transparent Encapsulation

The transparent encapsulation of a recently introduced wirewound resistor is said to assist in precluding service failures due to internal strains. Mechanical fastening, electric welding of all wire, leads and the phosphor bronze terminals were employed in constructing the new unit. They are designed to meet the requirements of government specifications JAN-R-93 and MIL-R-93A. Shallite, Inc., 10 Mill St., Paterson, N. J.

For more information—
Circle 81, inside back cover

Rugged Thermocouple With Fast Response

Used for measuring very rapid temperature changes of metal wall surfaces, this thermocouple is said to be applicable for recording temperatures in such equipment as gun bores, cylinder and piston walls, brake drums, aircraft skins, autoclave walls and air ducts. A plating of one micron (0.00004 in.) at the junction minimizes the response time of this instrument to temperature changes. It has been determined that the time required for the junction temperature to reach 63.2 percent of the amplitude of a stepchange of the exposed surface is approximately ¼ micro-second.

The thermocouple has been specifically designed to operate effectively under adverse conditions, and has been satisfactorily tested at pressures

to finish bearing and sealing surfaces to a flatness of .0000116 inches or less

...Microflat Machines use WINSMITH Speed Reducers

Whether it's soft non-ferrous metal, hardened steel or ceramic . . . any flat surface that can be machined, can be finished to any desired degree of flatness and surface finish on this Microflat Machine.

Mounted in a holding fixture, the work piece rotates and oscillates across a rotating finishing plate. Assuring correct speed for accurate abrading is a motor-driven Winsmith Worm Gear Speed Reducer, Model 6 BV, with an input of 3 hp at 1800 rpm and a reduction ratio of 16⅔ to 1.

"We have chosen the Winsmith Reducer because of its dependability . . . both in service and in meeting fast delivery schedules," reports Micromatic Hone Corporation, Detroit, Michigan.

Dependability of product and Company is a principal reason for the continual preference of rugged, compact Winsmith Reducers within the 1/100 to 85 hp range, in ratios from 1.1:1 to 50,000:1. Make sure your organization has the facts on this complete line of differential, worm gear, helical gear and worm-helical units.

For details, request Catalog 148 . . . and for information on Winsmith's new "C" Line Worm Gear Speed Reducers, request Bulletin 654.

WINSMITH, INC.
111 EATON ST.
SPRINGVILLE (Erie County), N. Y.

WINSMITH SPEED REDUCERS

MEMBER OF AGMA

Our special business is specials . . . special fabricated wire cloth parts made to your specifications. We save you time, we save you overhead, we save you production worries. And, you get a better part at a lower cost.

We weave our own cloth . . . your guarantee of quality components. We are fully equipped to do all necessary cutting, shaping, fitting, welding, soldering, punching, binding, etc.

For more information on this "One-Stop" Wire Cloth Parts Service, send for our latest Parts Catalog.

NEWARK for ACCURACY

Newark Wire Cloth COMPANY

351 VERONA AVENUE • NEWARK 4, NEW JERSEY

up to 60,000 psi under severe mechanical vibration. Two models of the thermocouple have been developed: a small one for use in thin walls and a large one for use in thick walls. Midwest Research Institute, 4049 Pennsylvania, Kansas City, Mo.

For more information—
Circle 82, inside back cover

Infinite Resolution Potentiometer

This 1½ in. dia potentiometer has a standard ⅜ in. threaded bushing for panel mounting a locating pin. It can be used as a direct replacement for applications requiring "stepless" potentiometer operation.

Available in standard three or ten-turn models, with resistance ranges of 6 to 2500 ohms and linearities of ±0.1 percent, and ±0.05 percent, these units are said to provide long life with low operation noise because of the true slide wire action. Power rating is 5 w for a ten-turn unit. Torque is 2 in.-oz. or less and its weight is 4 oz. G. M. Giannini & Co., Inc., 918 E. Green St., Pasadena 1, Calif.

For more information—
Circle 83, inside back cover

Miniature Panel Meter

A 1½ in. sealed panel meter is designed for one-hole mounting without conventional mounting screws and related hardware. Designated as Model 150, this miniature round panel instrument has a neoprene "O"-ring panel gasket which provides a positive watertight juncture between the meter and associated equipment. Terminal studs are similarly sealed. A knurled locknut with slots for wrench-tightening secures the instrument to the panel at the rear. Damage to the scale window will not destroy the watertight seal to the panel. High flux density "Alnico" magnets are used in this meter, with a miniaturized external D'Arsonval movement with external pivots. The external pivot design prevents pointer rocking and increases the life of the bearing surfaces.

Housing is shock-resistant, die-cast aluminum with corrosion-resistant black anodized finish. Standard instru-

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company DECEMBER 1954

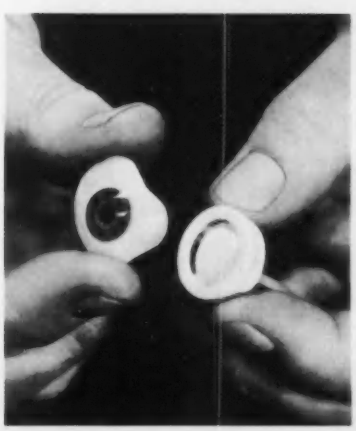
Insulator of KEL-F® Plastic Doubles as Vital Structural Part in Severe 250°F Water-Immersion Service

Perfect electrical insulation and maintenance of critical spacing of electrodes are provided by this spacer of KEL-F polymer plastic. Even under constant immersion in water at 250°F, insulation remains high, precision tolerances and dimensions of the spacer-insulator are maintained.

Excellent mechanical properties of this fluorocarbon plastic dielectric under extremes of temperature and stress permit the critical spacer to be used under heavy spring loading without deformation or failure. Accurately machined grooves in the plastic hold O rings to prevent liquid leakage.

McNab Incorporated, New York City, machines the spacers from rod extruded from unplasticized KEL-F polymer by the Resistoflex Corporation, Belleville, N. J. Spacers are used in special conductivity cell-valve units manufactured by the McNab company for use in marine and industrial installations producing potable water.

For further information ask for Application Report E-131



Prosthetic Eye Implants are Permanent—Non-Irritating to Living Tissue, They Retain Shape Indefinitely

Elimination of the necessity for periodic removal of prosthetic eye implants for replacement or "re-sizing" is the major advantage claimed for implants made from KEL-F polymer plastic. Once "fitted" to the individual eye socket, the implant retains its original size and shape, does not shrink or swell to cause pain to the wearer. The plastic's heat and moisture resistance allow it to be steam sterilized.

Since the fluorocarbon plastic is chemically inert, it does not cause irritation to adjacent sensitive tissues.

The plastic implant, known as the "Allen", is custom made from KEL-F polymer Grade 270 by Precision-Cosmet Co., Inc. of Minneapolis, Minn.

For further information ask for Application Report P-103

(SEE REVERSE SIDE)

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CONTINUED FROM PRECEDING PAGE

KEL-F® Polymer Teamed With High-Alloy Steel in New Centrifugal Pump For Corrosives, Sanitary Use

A KEL-F plastic O ring is used with Type 20 stainless steel and heat-resistant glass to create a new, low-cost centrifugal pump with extreme corrosion resistance and ready flow visibility.

The KEL-F plastic seal remains resilient, is unaffected by practically all known chemical agents over a wide range of temperatures and prevents damage to the glass cover plate. Unique physical characteristics of the plastic permit ready dismantling of pump and re-use of the O ring without loss of sealing effectiveness.

The new pumps, built by the Eco Engineering Company, Newark, N. J., use precision O rings molded of plasticized KEL-F polymer Grade 300 P-25 by Young Development Laboratories, Inc., custom molders of Rocky Hill, N.J.

For further information ask for Application Report C-121

Molders & Fabricators of the Month

Leading molders, extruders and fabricators specialize in the production of materials and parts made of "Kel-F" . . . each month this column will spotlight several of these companies with their principal services and products.

Auburn Button Works, Inc.
Auburn, N. Y.
Injection molding

Bacon Industries, Inc.
Watertown, Mass.
Compression & transfer molding
Gaskets & O rings

Elco Corporation
Philadelphia, Pa.
Injection molding
Electronic tube sockets

Electronic Mechanics Inc.
Clifton, N. J.
Extrusion, injection, compression & transfer molding
Forming
Rod, tube & sheet
Coil forms & tube sockets
Diaphragms & gaskets

A. Gusmer, Inc.
Stalpic Division
Woodbridge, N. J.
Corrosion control
Dispersion application

Recent Significant KEL-F Polymer Developments...

Lip seals for liquid oxygen and other liquefied gas equipment operating at low temperatures are molded now of KEL-F plastic. Resiliency at subzero temperatures, dimensional stability and chemical inertness overcome shortcomings of other gasket and sealing materials used.

Liquid level gauges now have their glasses protected by a thin sheet of KEL-F plastic. Remaining transparent indefinitely in spite of contact with highly corrosive chemicals such as HF, the plastic sheets act as their own gaskets.

Miniature coil forms are molded of KEL-F plastic for use in electronic devices operating at elevated temperatures. Types include special models with metal inserts.

Quality test for use by the manufacturer of trifluorochloroethylene polymer parts (the "Z.S.T." test) has been developed and field-tested by Kellogg. Test is simple, requires no special training. Equipment is automatic, eliminates the human error factor in test results.

OFF THE PRESS . . .
Revised "BUYERS GUIDE" listing KEL-F polymer products, molders and fabricators.

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANUFACTURING DIVISION
THE
M. W. KELLOGG COMPANY
P. O. Box 469, Jersey City 3, N. J.
or offices in Boston, Chicago, Dayton, Los Angeles and New York

KELLOGG PULLMAN

® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

ments are made with zero left scales, but zero center and zero right models are also available, in white or black and with various markings. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

For more information—
Circle 84, inside back cover

Packaged Servo System

This system includes amplifier, motor and gear train. The amplifier is equipped with screwdriver adjustment for a wide variety of load conditions. Indicated applications include synchro data transmission systems, follow-up systems, laboratory and industrial instrumentation, simulators, computers, fire control equipment, automatic systems. The unit is available with higher power outputs and for use with d-c systems.

Power output of the two available models are 1.5 w. Input impedance is 1 megohm. Typical damped natural frequencies are 12 and 40 cycles per sec. Feedback Controls, Inc., 1332-34 N. Henry St., Alexandria, Va.

For more information—
Circle 85, inside back cover

Tube Clamp Exerts 4 lb Min Pressure

Made of type 302 stainless steel, this electronic component exerts a 4-lb min retention pressure on a minimum diameter base, yet it never exerts so much pressure on maximum size bases as to cause breakage. This flexibility is said to eliminate the need in assembly to match clamps to tube bases. The Type 22 is made in sizes ranging from 1¼ to 6 in. ID, with several variations in location and height of the mounting bracket. Birtcher Corp., 4371 Valley Blvd., Los Angeles 32, Calif.

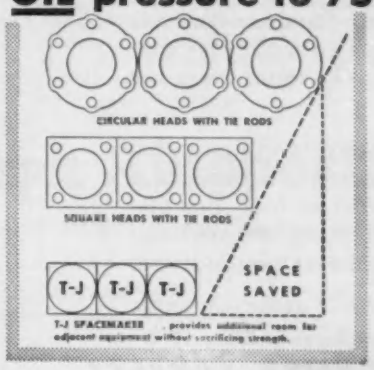
For more information—
Circle 86, inside back cover

Subminiature Toroid Coil

A toroid coil is being produced that consists of a sub-miniature molybdenum alloy toroid core with a winding having a residual hole as small as ⅛ in. Windings are impregnated

T-J
Spacemaker
CYLINDERS

OIL pressure to 750—AIR to 200 P.S.I.



Now the sensational new T-J Spacemaker sets the pace in compact cylinder design and efficient performance!

New "Self-Aligning" adjustable oil cushion means faster acceleration and better cushion than ever before . . . New T-J Super Cushion Flexible Seals for air insure positive cushion with automatic valve action for fast return stroke.

More plus features include—heavy wall, precision honed, hard chrome plated, seamless steel body . . . leakproof cylinder head to body construction . . . heavy duty, high-tensile, *hard chrome plated piston rod.* Write for bulletin SM-454-2. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

DAYSTROM FURNITURE

is Granodized

WITH "GRANODINE"®

FOR EXTRA PROTECTION

Long noted for beauty in styling, Daystrom Furniture also boasts that its black and golden bronze Coloramic can take it. Here's why: sturdy metal parts are Granodized before painting.

Granodizing is a protective phosphate treatment that bonds Daystrom's exclusive Coloramic finish to steel. Beautiful Daystrom Furniture is truly built for a lifetime of rugged use.

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"GRANODINE"® anchors the finish.

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AMERICAN CHEMICAL PAINT COMPANY

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DETROIT, MICH. NILES, CALIF. WINDSOR, ONT.

with a special compound and the finished coil is encased in an epoxy plastic.

Tinned No. 20 AWG wire leads are provided and the coil may be handled and mounted in the manner of its counterpart, the "postage stamp" mica condenser. Dimensions are $\frac{13}{16}$ x $\frac{13}{16}$ x $\frac{3}{4}$ in. thick.

The useful frequency range covers 1500 cycles per sec to 150 kc, dependent upon the inductance value. The unit is capable of withstanding temperatures from −55C to 125C, plus extreme environmental conditions. These coils are also available in the un-encapsulated form. Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif.

For more information—
Circle 87, inside back cover

High Speed Magnetic Clutches

Three high speed clutches have been introduced for use in all types of electronic and electromechanical control systems, computers and servomechanisms, as well as tape and film drive units and numerous other commercial applications. The clutches are the friction disc type and range from the $1\frac{1}{4}$ in. dia miniature to the $2\frac{1}{2}$ in. dia high torque unit. Torque ratings are available from 20 in.-oz to 125 in.-oz. Response time of the three models ranges from 0.005 to 0.025 sec, depending on the torque requirements. The stationary d-c coils are available in 12, 24, 48, 80 and 175 v. Ball bearings are used throughout to insure minimum friction. Instrument Components, Inc., 14-34 112th St., College Park, N. Y.

For more information—
Circle 88, inside back cover

Electro-Mechanical Amplifier

With this amplifier, a relatively small amount of power, 50 to 100 milliwatts, can control a large motor. The device is said to provide proportional control of the output shaft, which will rotate clockwise or counterclockwise as desired.

A combination of planetary gearing and stationary dry magnetic clutches

Glass containers for every purpose are designed and manufactured by Owens-Illinois Glass Company—over 100 billion units made in last 25 years

More than 3,000 new designs per year
—without a "bottleneck" in drafting

In the Design Development Department of the Owens-Illinois Glass Company, Toledo, Ohio, no time is lost in tedious redrafting. A simple short cut involving the use of Kodagraph Autopositive Paper and Kodalith Film *gives customers fast service . . . saves dollars every day.* Chances are you can adapt this technique to your own routines.

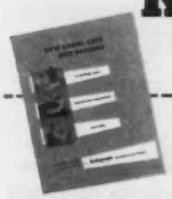
Big head start. Kodalith Film prints of elements which are repeated from time to time are kept on file. When a new design calls for any of these elements, the draftsman merely tapes the right films on clear acetate *and orders an Autopositive.* No redrafting!

A positive photographic intermediate is produced *directly* by exposing the "paste-up" in contact with Kodagraph Autopositive Paper, then processing the print in standard photographic solutions. No negative step . . . *easy room light operation.*

New design is added to the Autopositive, which has dense photographic black lines on a clean white translucent base. Required number of shop prints—each crisp and uniform—are produced from this master, which can also be used later on for minor revisions.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction



Shows all the ways you can save with Kodagraph Autopositive Paper.

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Industrial Photographic Division, Rochester 4, N. Y.

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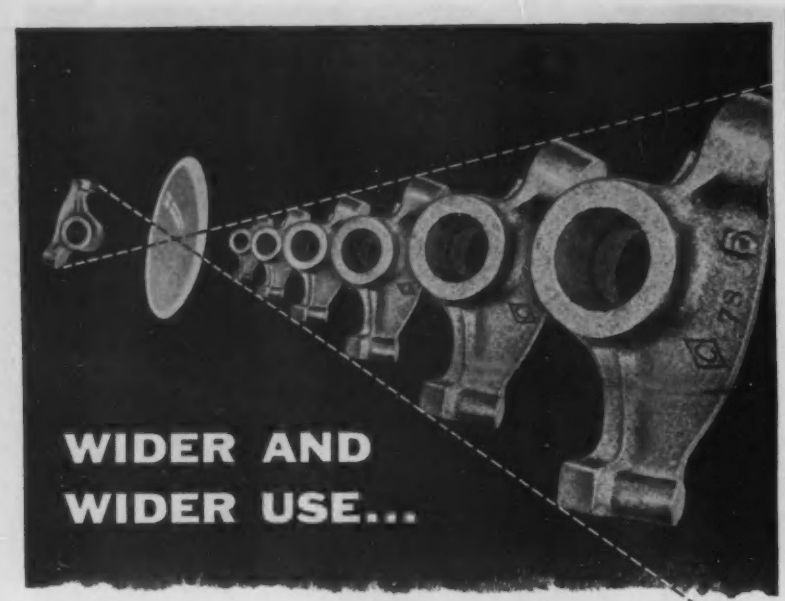
Kodak



PEARLITIC MALLEABLE CASTINGS as engineers see its many advantages

DESIGN ADAPTABILITY: Because of its good fluidity, it can be cast in thin sections and in complicated shapes.

HIGHER STRENGTH: Ultimate strengths range between 60,000 and 90,000 psi; yield strength between 40,000 and 70,000 psi.

EASILY MACHINED: Machinability index (B1112 Steel = 100) ranges between 80 and 90.

WEAR RESISTANCE: Withstands excessive wear under heavy loads at high speeds.

LOCALIZED HARDENING: Sections of the casting can be flame hardened or induction hardened before or after machining.

BEARING PROPERTIES: Good non-seizing properties in metal-to-metal contact.

FINE FINISH: Can be given a very smooth finish where desired.

You will find many applications for Pearlitic Malleable castings—particularly as a replacement for forgings, stampings and weldments—where reduced weight, less machining time, fewer assembly operations and better appearance are important production and sales considerations.

A-9277

NATIONAL MALLEABLE AND STEEL CASTINGS

COMPANY
Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

eliminates powder packing and slip rings, while the use of commercial gears eliminates the need for costly close tolerance gears. By the choice of various gear ratios, a variety of output shaft characteristics may be obtained.

Rated at 5 in. lb torque at 60 rpm, the unit is available for most standard line frequencies and voltages as well as a variety of gear ratios. The amplifier is 2¼ in. dia, 4⅞ in. long, and weighs 3 lb, 2 oz. Electomic Designs, Greenwich, Conn.

For more information—
Circle 89, inside back cover

Regulated Power Supply for Airborne Servo Systems

A tubeless magnetic amplifier-regulated d-c power supply for airborne application can be used for positioning potentiometer circuits which require a precise center tap. The MRP-15D-0.2 eliminates the need for batteries and provides a ±15 v, d-c output voltage with a precise differential regulation.

The −15 v channel is slaved to the +15 v channel to provide a precise differential regulation of 0.25 percent for combined changes in line voltage from 105 to 125 v, in line frequency from 380 to 420 cycles per sec differential load changes of ±10 percent, and in temperature from −55 C to 71 C. The unit operates from a 115 v, 400 cycle line. Ripple is less than 0.1 percent. Dimensions are 4⅞ x 3⅛ x 4½ in. Magnetic Research Corp., 200-202 Center St., E. Segundo, Calif.

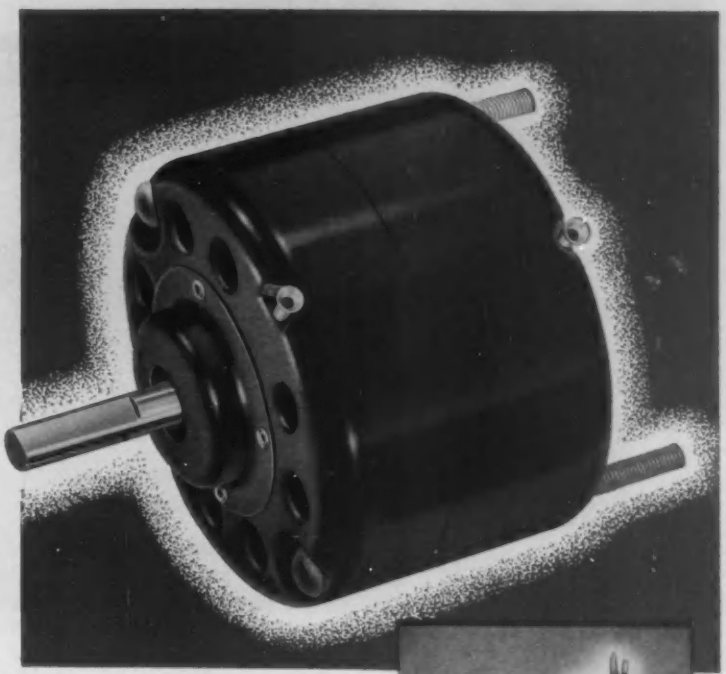
For more information—
Circle 90, inside back cover

Regulated D-c Power Supply

Conversion of a-c to d-c power with close regulation of d-c voltage without the use of moving parts or electronic tubes is provided by these regulated d-c power supplies. Voltage is regulated within ±1 percent.

Units range from 5 kw to 50 kw, and each unit is complete and self-contained, including magnetic-amplifier regulator, line contactor, protective equipment, meters and cooling fan. It is not necessary to separately pur-

Specify the NEW GI Smooth Power Model B MOTOR

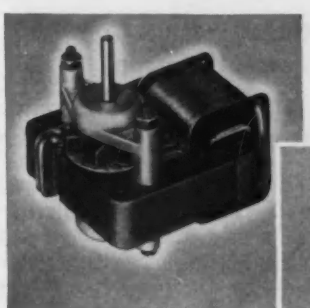


for Household Fans and Similar Operational Applications

Newest addition to the famous "Smooth Power" line . . . rugged, quiet, long-life motors specially designed for household fans and similar applications . . . and backed by over 25 years of GI leadership in subfractional motor manufacturing. The model "B" is available in four sizes: 1/40, 1/50, 1/70, and 1/110 H.P. Features include: shaded 4-pole, 4-coil design; self-lubricating, self-aligning bronze bearings; dynamically-balanced rotor; baked varnish-impregnated windings. For 115 volts 60 cycle AC. Write today for complete dimensions, specifications and quantity-price quotations.

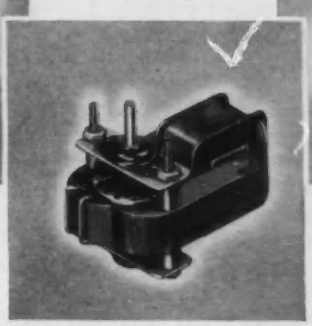
Other Smooth Power Motors for . . . • Ventilating Fans • Dictating Machines • Room Circulators • Recording Instruments • Automatic Record Changers • Centrifugal Pumps • Remote Tuners • Bathroom Heaters • Vending Machines • Animated Signs

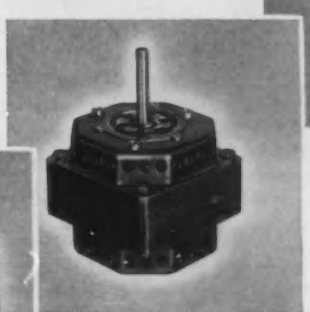
Model O — 2-pole Capacitor Type (for 6, 12 or 24 volt)



Model A — 2-pole A.C. Induction Type

Model C — 2-pole A.C. Induction Type





Model D — 4-pole A.C. Induction Type

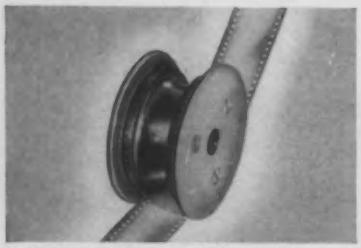
Send for *Smooth Power* Full Line Catalog

THE GENERAL INDUSTRIES CO.

DEPARTMENT MM • ELYRIA, OHIO

SYNTHANE

laminated plastics at work



In film processing *Synthane* is used in the manufacturing and processing of photographic films because it is durable, chemically resistant and does not fog sensitive emulsions.

In aircraft fuel systems
This fuel valve is made of *Synthane*. It is durable, ultra-reliable and resistant to the chemical action of gasoline. It is also light in weight.

In electrical appliances
Synthane is widely used in electrical appliances because of its high dielectric strength, ease of punching, and ability to withstand elevated temperatures.

What's your PROBLEM?
MAIL COUPON FOR FREE FOLDER

Our 25th Year
SYNTHANE CORPORATION
4 River Road, Oaks, Pa.
Please send me your free folder describing the advantages, properties, uses and kinds of *Synthane* plastics.
Name_____
Title_____
Company_____
Address_____
City_____ Zone_____ State_____

chase and install starters, meters, regulators or other equipment. Neither do these power supplies require special installation procedure. They can be moved quickly from one job site to another.

Standard models available are 5, 7.5, 10, 15, 25, 37.5 and 50 kw. D-c output is 125 v or 250 v. Vickers, Inc., 1815 Locust St., St. Louis 3, Mo.

For more information—
Circle 91, inside back cover

HYDRAULICS AND PNEUMATICS

Two-Position, Four-Way Selector Valve

This selector valve for low pressure air or hydraulic systems is described as being leakproof at working pressures up to 100 psi and as maintaining low handle torque. Handle stops assure positive alignment of ports. The black, anodized, cast aluminum body is $2\frac{1}{2}$ in. wide, $1\frac{3}{8}$ in. high. Weight is 6 oz. Complete disassembly is possible without disconnecting system lines. Sprague Engineering Corp., Gardena, Calif.

For more information—
Circle 92, inside back cover

Air Clutch With Sensitive Control Response

This clutch's sensitivity is said to provide "finger-tip" control and the ability either to "inch" the device or to throw it into full engagement. Instant disengagement of the clutch is achieved by the use of quick release valves built into the clutch itself. These valves are optional equipment.

Provision has also been made for internal ventilation. The flexible air seal disc is so located that it does not come in contact with the heat generating plates. Mechanical engagement of the clutch, in case the air supply fails is possible. The new clutch interchanges with and can be used to replace mechanical clutches in existing installations. It is available from stock in single and double plate models from 8.5 to 806 hp per 100 rpm at 80 psi. Dodge Mfg. Corp., Mishawaka, Ind.

For more information—
Circle 93, inside back cover

Pneumatic Valves

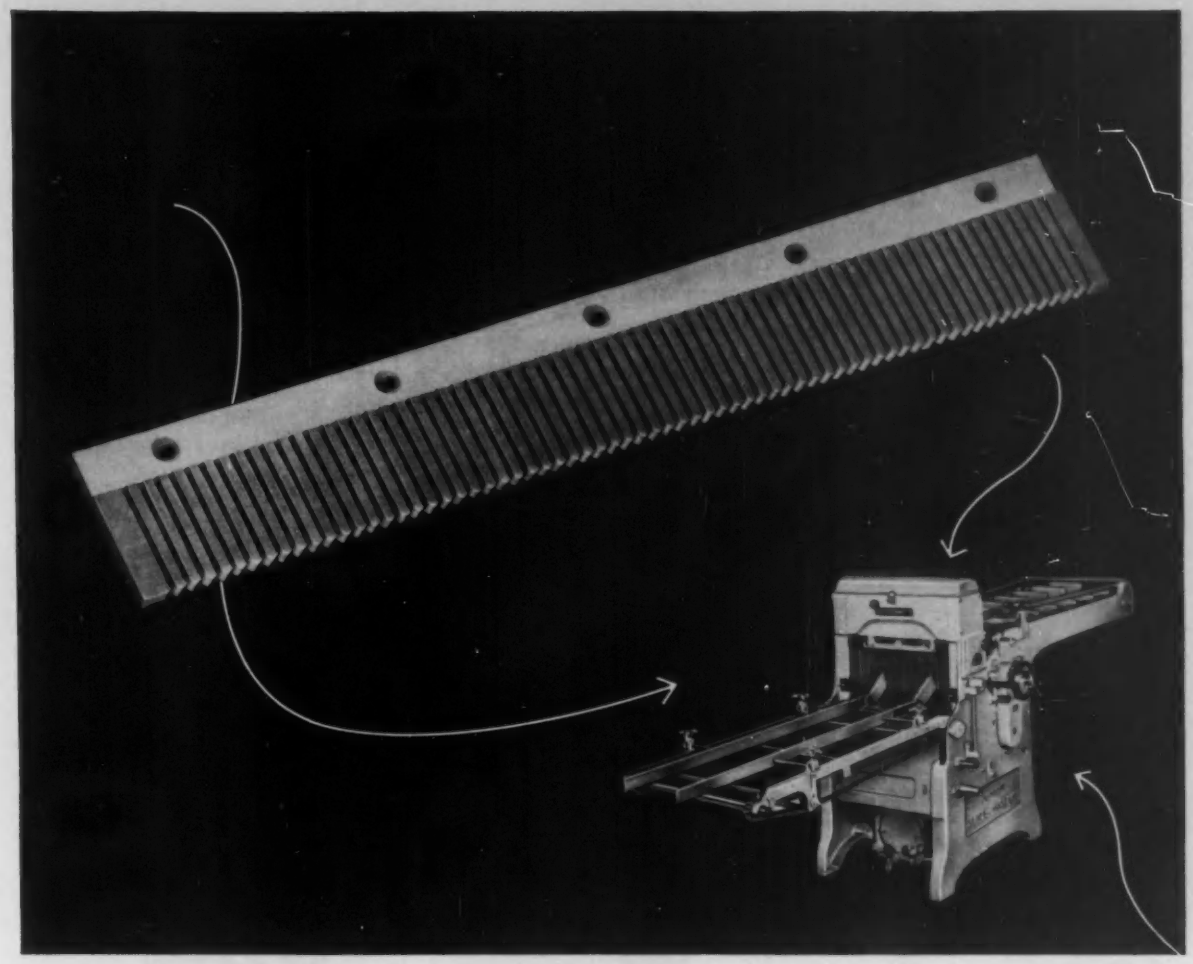
Solenoid-operated shutoff and selector valves for aircraft, guided missiles, and industrial applications have a pressure range of 0 to 3000 psi, with a service temperature range of −65 F to 265 F. Electrical current drawn by the valve is less than 1 amp at 24 v, dc, continuous duty. Mar Vista Engineering Co., 5420 W. 104th St., Los Angeles 45, Calif.

For more information—
Circle 94, inside back cover

Rotating Ring Controls Hydraulic System

This ring balance meter, commonly used for all types of flow metering, is now available for controlling the water level in high pressure bottle accumulator systems supplying storage for pumps used to operate high pressure hydraulic presses of 2000 psi and upwards. In this system, the accumulator bottle employed is the air-loaded type rather than the individually loaded piston type. The air bottle accumulator system is considered preferable because the total pumping capacity for normal operation of all presses can be reduced to approximately 50 percent of the total requirement of each press.

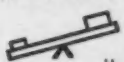
The ring balancer meter measures the water level directly. Changes in



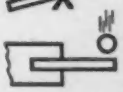
How Synthane Guides help Slice your Bread

Properties of Synthane

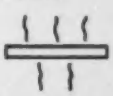
Here are some additional properties of Synthane which you may find of interest:



Light in weight. Despite its hardness and density, Synthane is only about one half the weight of aluminum.



High impact strength. Synthane stands up well in applications where it is subject to vibration, pounding and light shock loads.



Thermosetting. Synthane laminated plastics are thermosetting, they cannot be re-heated and reworked. They hold their shape under elevated temperatures.

Low moisture absorption. Most grades of Synthane are highly moisture resistant. Special grades are available for applications where absorption must be at a minimum.

Availability. In addition to more than 33 grades of sheets, Synthane is also supplied in rods, tubes and special shapes. Molded-laminated and molded-macerated parts are manufactured. A complete fabricating service is available.

● Pre-slicing bread presents an interesting opportunity for the use of *Synthane* laminated plastics. Comb-like guides of bread slicing machines hold the loaves in position and control the blades during the cutting action. These guides are made from *Synthane* because *Synthane* has certain properties in combination which well fit it for this job.

Synthane guides are hard, smooth, and easy to clean. They reduce friction and are dimensionally stable and light in weight. They are non-toxic, suitable for use in handling food products. And they can be easily and quickly machined to the shape required.

Our 25th Year

SYNTHANE CORPORATION, OAKS, PA.

When *Synthane* was first produced twenty-five years ago, it was regarded primarily as an electrical insulating material. Today its chemical, physical, and mechanical properties, in addition to its high dielectric strength, are being put to work in many different fields.

If you have need of a material with multiple properties in combination, *Synthane* may be your answer. Our catalog gives full data on many different grades of *Synthane* sheets, rods, tubes and molded parts. We will be glad to send you a copy on request. Address Synthane Corporation, 4 River Road, Oaks, Pa.

SYNTHANE

LAMINATED PLASTICS

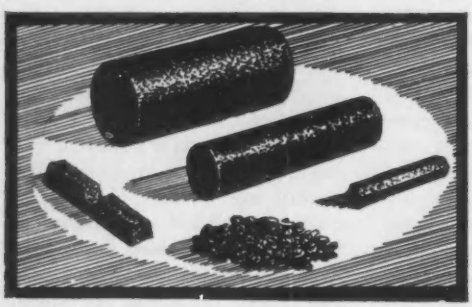
You can't beat Cannon-Muskegon MasterMet alloy service

...for fast delivery of standard or custom certified* alloys for remelt or reprocessing!

CANNON-MUSKEGON regularly produces a wide range of certified alloys to maintain one of industry's finest stocking programs. Immediately available are stainless steels in the 300 and 400 series *plus* certain carbon steels.

Service on "special" alloys is remarkable too!

Preparation is begun immediately after your specifications are received. You get *exactly predictable* physical, chemical and electrical properties to your specific requirements. And, depending upon the form you order, alloys can be cast, forged, extruded and machined. Furnished regularly to investment casting foundries and other users are alloy tool steels, ferritic and austenitic stainless, alloys of cobalt and nickel-base, plus aeronautical-types for extreme high temperature applications.



MasterMet alloys are available in ingot, shot, billet or short (6" dia.) cast bar forms and are normally shipped in drums. Specifications, weight, lot and customer's order number are clearly imprinted on container, making selection and storage a simple matter.

*Cannon-Muskegon furnishes notarized certificates of analysis to meet prescribed metal specifications. For more information about this, and complete technical service, write for New MasterMet Bulletin.

Cannon-Muskegon
CORPORATION
2877 Lincoln Street
MUSKEGON, MICHIGAN

MASTERMET

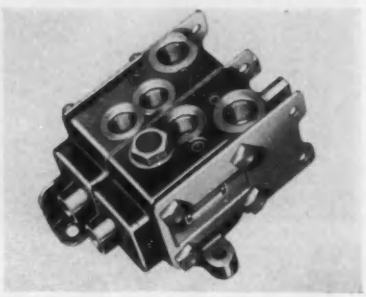
METALLURGICAL SPECIALISTS

the water level cause rotation of the ring which in turn closes or opens mercury switches in a sequential operation, making possible automatic control of the pumps.

Each pump is started by a decrease in water bottle level, actuating the mercury switch at a predetermined point. The pump is stopped as the level increases to the second predetermined point. Switches are staggered to actuate the proper number of pumps to meet the load demand.

The ring balance level gage used in the operation is designed and adapted for accumulator bottle control and similar systems and is suitable for direct calibration of 300 in. water column. Hagan Corp., Pittsburgh, Pa.

For more information—
Circle 95, inside back cover



Multiple Unit Valve For Mobile Machinery

Metering characteristics are asserted to be improved in these valves, permitting greater precision in nudging, crowding and inching operations. They are expected to prove applicable to materials handling equipment, road and construction machinery, farm implements and trucks.

The new valves are made up of standardized and interchangeable units assembled in combinations (up to eight sections) between special combination inlet and outlet units. The new inlet section is a single casting that combines inlet manifold, operating valve and relief valve. The new outlet unit is also a one-piece casting combining outlet manifold, operating valve and end plate. This combined form makes the valve physically smaller than would be possible using all separate sections. Individual end plates are also available for applica-

tions involving the use of a single operating valve.

The new series is also available in double-acting and single-acting models. Single acting valves are available for either direction of lever shift. "O" ring seals provide leakproof joints between the mating faces of valve sections.

Maximum working pressure for these new valves is 2000 psi. Pressure drop through the valve is 50 psi. Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

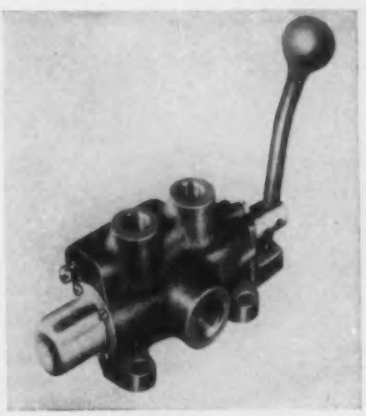
For more information—
Circle 96, inside back cover

Uses Air Line To Provide Hydraulic Pressure

This line of 39 models of an air-powered pump used for hydraulic pressure, roll pressure, testing operations is controlled by means of a single valve, it is asserted. The unit has a ratio of 690:1 and will produce up to 60,000 psi hydraulic pressure with an air supply of 100 psi.

Body of the new pump is bronze and the ram is Monel. Temperatures up to 320 F can be handled by standard models. Davies Brothers, 120 Wall St., New York 5, N. Y.

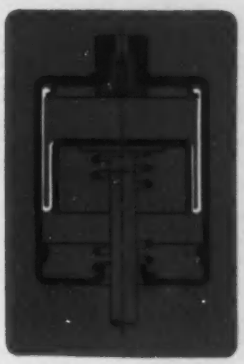
For more information—
Circle 97, inside back cover



Four-Way Hydraulic Control Valve

This control valve has a built-in adjustable relief valve. It is a three-position valve with open center spool, spring return to neutral. The spool is hardened, ground and chromeplated.

Bellofram*
PISTON SEAL



...easy to apply

NEW CLASS 1 BELLOFRAM

The new solid head Class 1 Bellofram is a long stroke, deep convolution piston seal diaphragm developed for all pressure sealing applications. With the "O" ring bead-seal characteristic, it will operate efficiently at pressures up to 500 p.s.i. — or up to ten times the rating of ordinary diaphragm seals.

EASE OF APPLICATION SIMPLIFIES YOUR DESIGN PROBLEMS

Actuators using Class 1 Belloframs have longer stroke — are smaller, lighter, much easier to design and manufacture — do not require costly machining or precision alignment. Bellofram's *rolling action* (not sliding) minimizes friction losses. Dynamically stable Belloframs are made of modern fabrics and elastomers for high resistance to fatigue and extreme cycle life. The bead is not subject to operational stress, due to provable wall-friction coefficients and narrow semi-circular convolution of diaphragm under pressure.

FLANGELESS BELLOFRAMS FOR *YOUR* APPLICATION

Put this major improvement in piston seal design to work for you now. Bellofram's unduplicated features include resistance to vibration and chemical action — operation over a wide temperature range — elimination of leakage — control of effective area to within 0.1% over complete working stroke. No lubrication needed — no maintenance except simple, infrequent replacement — accurate, economical operation where ordinary seals fail. Outline your application and submit a sketch to find out how a standard or custom-engineered Class 1 Bellofram can solve your pressure application problems. Your data considered confidential. Write today.

* Trade Mark

Bellofram
CORPORATION
144 MOODY ST., WALTHAM, MASS.

FORWARD!

by

LUBRIPLATE LUBRICANTS

The introduction of LUBRIPLATE Lubricants established a new high standard for industrial lubrication. Now, a recently patented improvement in the production of LUBRIPLATE results in even greater lubrication efficiency. Under today's operating costs, reduction of down time, less parts wear and replacements, as well as lower power consumption, far outweigh any differential in the initial cost of LUBRIPLATE Lubricants.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Write for your free copy of the new and enlarged LUBRIPLATE DATA BOOK—a most valuable treatise on modern lubrication!

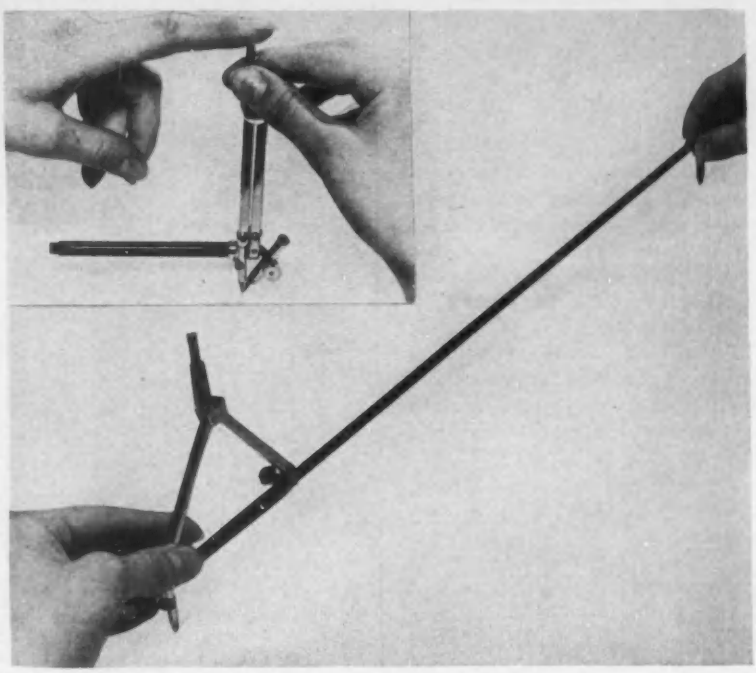
LUBRIPLATE DIVISION
Fiske Brothers Refining Co.
Newark 5, N. J. • Toledo 5, Ohio

The handle can be mounted in any of four positions. The relief valve is factory set at 1000 psi, but is adjustable from 750 to 1500 psi.

This valve is designed for double-acting hydraulic cylinders. It is a pressure-balanced, sliding spool hydraulic valve, suited for operating hydraulic loaders, dumps, push-offs, farm tractor implements and industrial hydraulic equipment. It can be used as a single unit or mounted in series for multiple control situations on all types of hydraulically actuated equipment. Dukes Co., Inc., 2108 N. Southport Ave., Chicago, Ill.

For more information—
Circle 98, inside back cover

ENGINEERING EQUIPMENT



Drafting Compass Draws Circles Up to 1 Meter In Radius

A combination bow, beam and interchangeable-points drafting compass was recently introduced in Stockholm. By simple thumbscrew adjustment, the compass draws circles of radii from less than 0.5 mm up to 200 mm (8 in.). With the device's extension beam, circles up to 1 meter in radius can be drawn. They are equally accurate using lead, ink or scribing point.

The new compass is stable in movement. Dimensions do not change, once set, because the setting is locked by the thumbscrew. Regardless of size of the radius, the center pin is always vertical to the drawing-board. The inclination set on the lead likewise remains the same regardless of radius. Available from abroad only. AB Produktionmateriel, Norra Stationsgatan 53, Stockholm, Sweden.

For more information—
Circle 99, inside back cover

Corona Testing Device

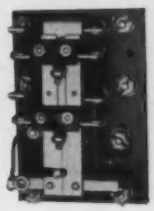
This set has been designed to facilitate nondestructive testing of the insulation in electrical equipment. This is accomplished by the detection of electric discharges that may result when an a-c test voltage applied to such equipment exceeds a critical value. In many types of electrical

ASCO ELECTROMAGNETIC CONTROLS FOR INDUSTRY

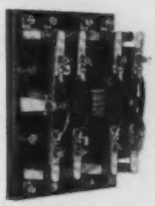
ASCO designed and manufactured electromagnetic control devices provide completely automatic control systems for all industry—marine, communications, power, lighting, heating and machinery. Since 1888, Automatic Switch Company has pioneered in new developments that meet the advancing needs of modern industry.

RELAYS

MECHANICALLY HELD...AC or DC...single throw ...double throw...600 volts maximum.

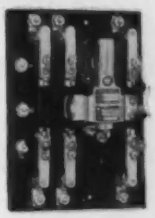


Bulletin 1255
AC or DC, single and double throw; 25 amps.

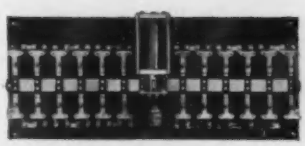


Bulletin 1255-166S
AC, single and double throw; up to 6 poles double throw; 25 amps.

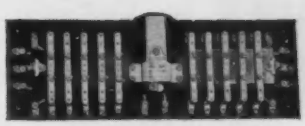
MAGNETICALLY HELD
...AC or DC...normally open...normally closed... double throw. Up to 12 poles...25 amps...600 volts.



Bulletin 1054
AC; double throw, 3 pole, 25 amps.



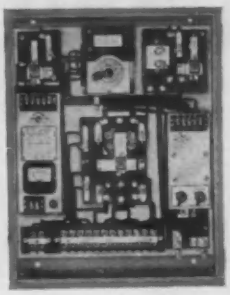
Bulletin 1058
DC relay; double throw, 12 pole, 10 amps.



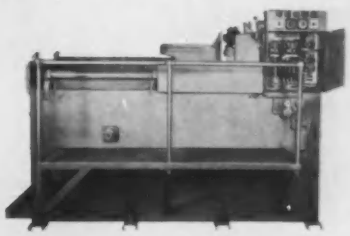
Bulletin 1055
AC relay; double throw, 10 pole, 10 amps.

Special Purpose Relays—*Close Differential...Reverse Current...Time Delay.*

COMPLETE CONTROL PANELS . . . ASCO engineered and manufactured . . . are provided by combining ASCO Electromagnetic Controls with purchased equipment as needed.

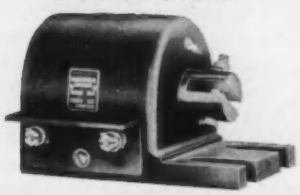


The 2 pole, 30 ampere ASCO Automatic Transfer Switch Panel conforms to RETMA standards for emergency standby power generators and accessories for microwave installations. An automatic lockout relay prevents transfer until electric plant rated voltage and frequency are attained.



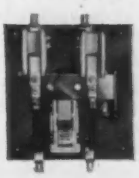
PRECISION SHELL-MOLDING PROCESS is completely controlled by ASCO Solenoid Valves and Electromagnetic Controls. The Electromagnetic Control Panel controls the valves, adjusts the heat input and times the investment and curing cycle.

SOLENOIDS

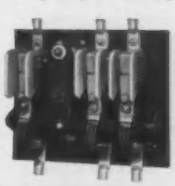


For AC or DC service, ASCO solenoids are selected and engineered for your particular application to insure trouble-free performance.

CONTACTORS — Magnetically held . . . AC or DC . . . normally open . . . normally closed . . . double throw. Heavy duty for all type loads.



Bulletin 1025
Normally open; single throw. 2 pole, 100 amps., 250 volts DC



Bulletin 1035
Normally open; single throw. 3 pole, 200 amps., 600 volts AC

FOR DETAILED INFORMATION ON ASCO ELECTROMAGNETIC CONTROL EQUIPMENT — AND ITS APPLICATION TO YOUR NEEDS — WRITE US TODAY.

To learn more about ASCO equipment: See Section H of the 1955 Annual Handbook of Product Design for ASCO Electromagnetic Controls for standby emergency power installations. See Section J for information on the extensive line of ASCO Solenoid Valves.

Automatic Switch Co.
385 LAKESIDE AVENUE • ORANGE, NEW JERSEY

ASCO Electro-Magnetic CONTROLS

DIAPHRAGM OPERATED CONTROL VALVE WITH

Full Port Diameter AND *4-Position Indexing*

- Also applicable wherever desireable to control line flow by use of independent pressure on the diaphragm. Type D-53 is finding wide acceptance in substitution for expensive Solenoid Valves.
- Full port means high capacity. All bronze housing. Renewable chrome plated valve seat and composition seat disc. Neoprene nylon diaphragm. Also available with adjustable maximum and/or minimum flow limit stops.
- For additional information on Type D-53, and other new automatic valves in the Cash-Acme line, write our Engineering Department at the address below. To avoid delay, please include a brief outline of your pressure conditions and requirements.

This new pressure operated valve is offered in two basic types . . . either normally open and *closed* by diaphragm pressure or normally closed, and *opened* by diaphragm pressure. Typical use is on water cooled compressors.

Type D-53 may be used to handle water, air, oil or any non-corrosive fluids. Maximum body pressure 250 psig; diaphragm pressure 300 psig. For maximum hookup flexibility, the diaphragm pressure connection on this new Cash Acme valve may be indexed to any of the following four positions:

1. Over inlet
2. Over Outlet
3. Right Side
4. Left Side

CASH ACME A. W. CASH VALVE MANUFACTURING CORP.

6662 E. Wabash Avenue Decatur, Illinois

The Complete Cash-Acme Line Includes Pressure Reducing and Regulating Valves, Relief Valves, Back Pressure Valves, Vacuum Regulators and Vacuum Breakers, Differential Pressure Regulators, Strainers, Diaphragm Control Valves.

1-54

equipment, the absence of discharges at the operating voltage level is sufficient assurance that the insulation is in good condition at the time of test. This is particularly true of dry organic insulations. This method of testing is reported to have been used successfully on cables, transformers, capacitors, terminations and, to some extent, on motors and generators. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

For more information—
Circle 100, inside back cover

Regulated Power Supply

A regulated power source of conventional circuitry, this instrument is asserted to be useful as an experimental tool in the electronics laboratory or in production testing. Output voltages from 0 to 400 v, continuously variable, with currents up to 200 ma are available. Regulation is maintained at ¼ percent with hum levels of less than 20 mv. A variable negative output of 0 to 150 v is also provided for bias, as well as 6.3 v, ac, at 8 amp. Positive and negative terminals are insulated from the chassis, permitting high voltage to be used above or below ground. Beckman Instruments, Inc., P. O. Box 296, Station A, Richmond, Calif.

For more information—
Circle 101, inside back cover

Power Supply Furnishes 150 to 500 v

Continuously variable voltage from 150 to 500 v and up to ½ amp of d-c current with 0.002 percent load regulation and less than 100 microvolts of ripple over the entire operating range is provided. Impedance is 0.01 ohm for dc and low frequencies and is less than 0.05 ohm for frequencies as high as 50 kc.

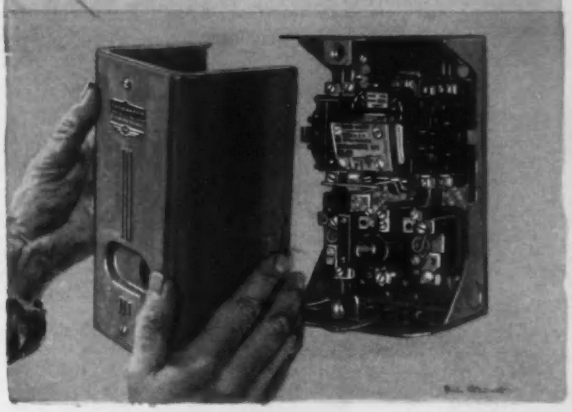
Full-rated maximum current can be drawn with 100 percent duty cycle at any output voltage and at any line voltage from 105 to 125 v with a substantial safety factor. Drift is kept very low by the use of drift-cancelling differential amplifiers, a new high stability reference tube and low temperature-coefficient wire-wound resistors.

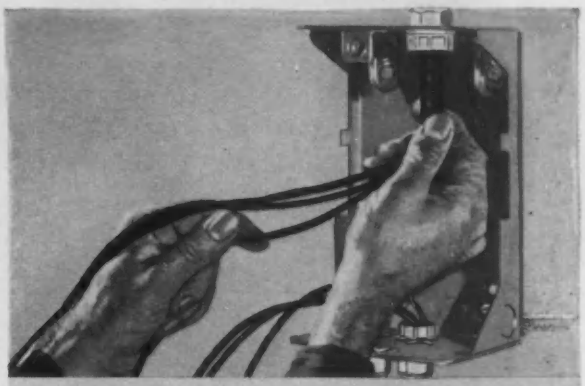
The d-c output is controlled by a

THE THREE CUTLER-HAMMER STARS ★ ★ ★ STAND FOR THREE NEW STANDARDS

☆ installs easier
☆ works better
☆ lasts longer

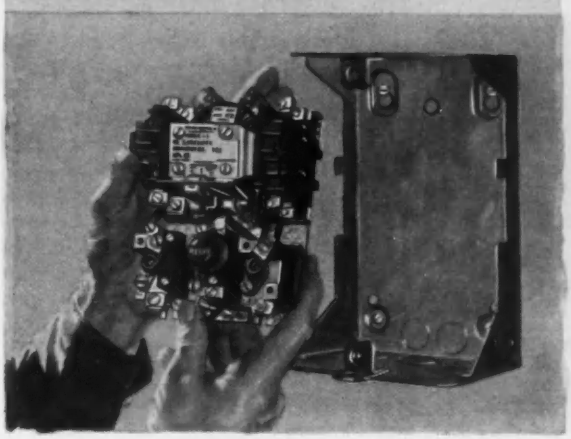
1. Just loosen two screws . . . and off comes wrap-around cover. Screws stay in cover, do not fall into machines or get lost on floor; a typical time-saving design detail.

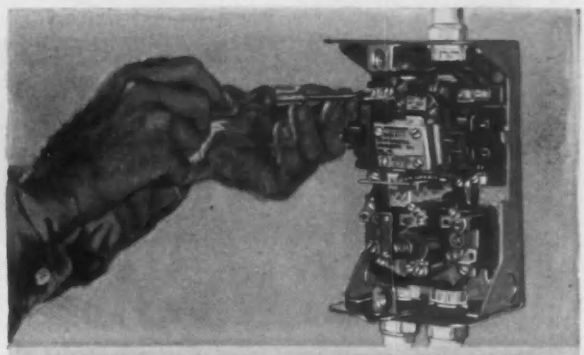




3. Pull in wires . . . Making conduit connections and pulling wires is a cinch. No starter mechanism or side walls of case in the way. No skinned knuckles or damaged starters.

2. Remove entire starter mechanism . . . by merely loosening three screws. Then light, easy-to-handle skeleton case can be installed. Embossed mounts for good job on uneven surfaces. And upper mounting holes are keyhole slotted.



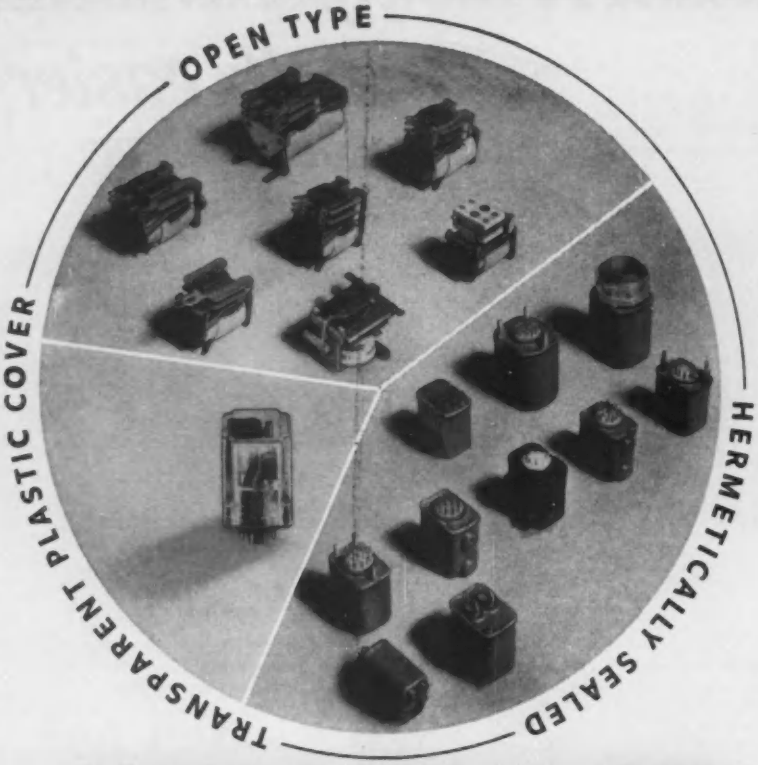


4. Connect up and go . . . Straight-through wiring; all line terminals at top, load terminals at bottom. All terminals are clearly marked and visible from front. Pressure connectors throughout. All panel wiring is color coded.

Factory records everywhere today show the cost of installing motor control is almost always greater than the cost of the equipment, often two to three times as much. That is why Cutler-Hammer engineering made easier installation a key objective in designing the new Cutler-Hammer ☆ ☆ ☆ Motor Control. When you buy motor control, figure its *real* cost, its installed cost. Then you too will insist on Cutler-Hammer! Your nearby Cutler-Hammer Authorized Distributor is ready to serve your needs. Order from him today.

CUTLER-HAMMER, Inc., 1332 St. Paul Ave., Milwaukee 1, Wis.

CUTLER-HAMMER ★ ★ ★ MOTOR CONTROL



R-B-M Relays

FOR EVERY ELECTRONIC APPLICATION

Meeting Commercial and Government Requirements

OPEN TYPE. Circuit switching—power and dynamotor loads—plate circuit—low capacitance.

HERMETICALLY SEALED. Stud or bushing mounting—solder or plug-in headers—circuit switching—power—low loss applications.

TRANSPARENT PLASTIC COVER. Most R-B-M relays now available in low cost transparent plastic cover.

OTHER PRODUCTS: Motor starting relays and overload protectors for refrigeration, appliance and general purpose motors. Industrial contactors and across-the-line starters. NEMA size 1 and smaller. Low cost general purpose relays. Low voltage D.C. manual and magnetic devices.

Let R-B-M engineering and production facilities serve you. Contact us immediately—Phone 5121

R-B-M DIVISION
ESSEX WIRE CORPORATION
Logansport, Indiana

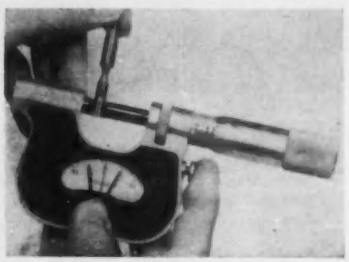
Controls for Electronic, Refrigeration, Industrial, Appliance, Communication and Automotive Industries

RBM

precision wire-wound potentiometer, ganged with a variac to obtain good efficiency at the lower output voltages. Two ruggedized hermetically-sealed 3½ in. meters are provided on the front panel for monitoring current and voltage. There are two independent 6.3 v, ac, 10 amp outputs.

The Model UHR-245 is available either in a cabinet for bench use or with a rack panel 8¾ in. high. Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.

For more information—Circle 102, inside back cover



Micrometer With An Indicating Dial

An indicating micrometer has a range from 0 to 1 in., reading in 0.0001 in. The indicating mechanism is reported to control the measuring pressure so that all uncertainties due to differences in "feel" of individuals are eliminated. The device also detects out-of-roundness, ovality and taper. The release button for the movable anvil is on the right, making it a right-hand tool.

Resetting to zero is accomplished by means of a screw on the bottom of the housing. This can be done accurately in less than 5 sec. Tungsten carbide anvils and finished hard-wood case are standard equipment. Larger sizes up to 4 in. are furnished with removable indicator. George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

For more information—Circle 103, inside back cover

Selenium Rectifier Kits

Kits containing vacuum processed selenium rectifiers have been made available which contain fully assembled units marked with commercial coding. It is asserted that the series

of seven kits will permit the engineer to have on hand the full range of commercially available selenium rectifiers, saving the usual week to 10-day delay in obtaining samples.

The new series offers a complete range of sizes and rating from ¼-in. dia plates to 5 x 6 in. plates, with ratings from 1.5 ma dc up to 3700 v peak inverse to types rated at 10 amp and 222 v. Bradley Laboratories, Inc., New Haven, Conn.

For more information—
Circle 104, inside back cover

HighVoltage D-c Test Set

For plant and laboratory use in testing wire and cable rated up to 15 kv, rotating machinery and insulating materials, Model 437 has an output voltage of to 0.45 kv, read on a 4½ in. voltmeter connected directly across the output. Maximum output current at rated voltage is 2.5 micro-amperes read on a 4½ in. micro-ammeter.

Output is obtained through a voltage doubler circuit with metallic diodes, eliminating rectifier tubes and filament transformers. The diodes, filter capacitors, meter multipliers and transformer are completely oil-immersed for corona-free operation. Ripple is less than 5 percent at maximum output voltage and current.

The laboratory model's steel case measures 24 x 24 x 36 in. Net weight is 250 lb. Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.

For more information—
Circle 105, inside back cover

Single-Channel, Rack-Mounted Scope Offers Wide Application

This instrument, according to its maker, should prove useful to electric and electronic manufacturers, amateur radio operators and broadcasting and telecasting stations who seek the advantages of rack mounting.

All components are accessible despite the rack mounting. Mechanical slide mechanisms, which permit the entire unit to be drawn out and then turned in a vertical position, may be installed easily through holes provided in the side plates. Once exposed, all

For Dependable Protection On Hydraulic Equipment

SUMP TYPE
(cutaway)

MARVEL SYNCLINAL FILTERS

Over 500 Original Equipment Manufacturers Install Marvel Synclinal Filters as Standard Equipment.

LINE TYPE
(cutaway)

Hydraulic Oils MUST BE CLEAN to Protect Equipment— Increase Production— Reduce Maintenance

PRODUCTION ENGINEERS and MAINTENANCE MEN, whose job it is to keep production machinery operating at peak efficiency, are specifying Marvel Synclinal Filters on new equipment and standardizing with Marvels throughout their plants.

It's The ACTIVE Filtering Area That Counts!

The Synclinal design of Marvel Filters provides that all-important balance between maximum ACTIVE filtering area and sufficient storage capacity for filtered out particles. Thus, longer periods of productive operation are attained before filter cleaning is necessary. Marvel Synclinal Filters are easy to clean because both the sump and line type may be disassembled, thoroughly cleaned and reassembled in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

IMMEDIATE DELIVERY!

As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

FILTERS FOR NON-FLAMMABLE HYDRAULIC FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of non-flammable hydraulic fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclinal design.

Catalogs containing complete data available on request

MARVEL
ENGINEERING COMPANY
625 W. Jackson Blvd.,
Chicago 6, Ill.
Phones—Franklin 2-3530 and Franklin 2-4431

Without obligation, please send me complete data on Marvel Synclinal Filters, as follows:—

☐ Catalog #106—For Hydraulic Oils, Coolants and Lubricants
☐ Catalog #300—For WATER
☐ Data on filters for Non-flammable hydraulic fluids.

Name .....
Title .....
Company .....
Address .....
City .....
State PE-12

components are clearly identified for fast servicing.

The FT-11 employs a 5-in. flat-face cathode ray tube of the electrostatic focus and deflection type. Accelerating potential is 2000 v, overall. Frequency range of both horizontal and vertical amplifiers is 0 to 100 kc, ±100 db, down 3db at 200kc.

Aluminum is used throughout to minimize weight. Power consumption is 104 w, 115 v, 45 to 65 cycles. Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Penna.

For more information—
Circle 106, inside back cover

Hand Stroboscope

This hand stroboscope is a light, portable instrument for measuring revolutions and for visual observation of all fast periodic motions. It does not require any electrical connection, as it is operated mechanically by a spring movement.

In spite of its simplicity the instrument is said to have an accuracy within 1 percent and its range is from 400 to 12,000 rpm. The instrument weighs less than 2 lb. Epic, Inc., 154 Nassau St., New York 38, N. Y.

For more information—
Circle 107, inside back cover

Power Supply Rated At 28 v, 100 Amp

A light weight magnetic amplifier regulated power supply contains no moving parts other than the cooling fan and is 25 in. long, 15 in. deep, 15 in. high. Ripple is 1 percent and regulation ±1 percent. Response time is 0.2 sec; weight, 250 lb. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information—
Circle 108, inside back cover

Drafting Template for Small Machine Screws

This template has a range of six common sizes, from ¼ to No. 6 screws. The root diameter of screws in both elevations may be drawn by using the respective cut-outs of the smaller sizes. Provision is made for

THIS PRESIDENT DISCOVERS A NEW WAY TO CUT COSTS

"We invested $774 in Farval... save $5,000 in press repairs annually"

"This forging press in our Louisville plant shut down because bearings burned out when the oiling system failed. It cost us $5,000 to overhaul the press and put in new bearings. Even more expensive was the production time we lost.

"We installed a Farval system of automatic centralized lubrication. *It cost only $774* and good results were immediate and continuing! Lubrication was set to the exact frequency we needed. Oil delivered to the bearings was accurately measured. We've not had a single press breakdown since, so we've been spared many $5,000 repair bills in our seven years with Farval, to say nothing of other thousands saved in lubricant, oiling labor and production time.

"We like Farval so well that we've installed nine more systems to protect 664 bearings on other presses. Farval is an investment that's guaranteed to pay off in a big way."

FARVAL is the foolproof Dualine system of centralized lubrication that delivers a measured amount of clean lubricant at regular intervals to every bearing. From a central station, lubricant is pumped under pressure to a measuring valve at each bearing, delivering the exact amount of lubricant required.

FREE LUBRICATION SURVEY
Let us send one of our lubrication engineers to inspect your plant equipment. Without obligation, he will present a written analysis of what Farval can do for you. Write also for Bulletin 26 for the complete Farval story.

The Farval Corporation
3279 EAST 80th STREET • CLEVELAND 4, OHIO

Farval is an affiliate of The Cleveland Worm & Gear Co., Represented in Canada by Peacock Brothers, Limited

Example of a permanent mould casting of a crankcase for a 49 c.c. 2-stroke engine

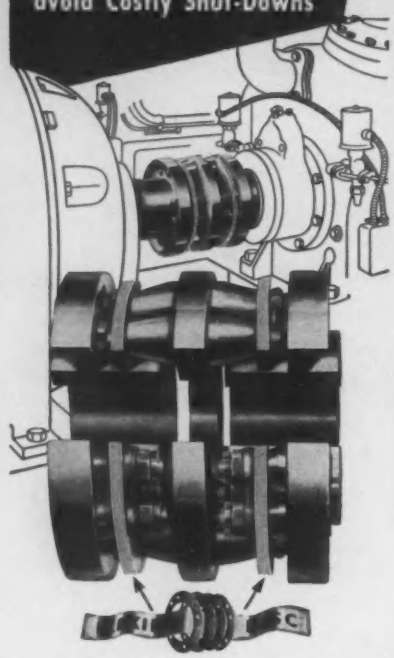
Hiduminium

makes the most of *Aluminium*

HIGH DUTY ALLOYS LTD., AGENTS: RUSSELL ASSOCIATES INCORPORATED

165 ORINOCO DRIVE, BRIGHTWATERS, L.I., N.Y.

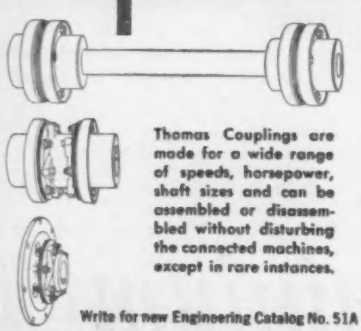
Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.

DISTINCTIVE ADVANTAGES

FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Thomas Couplings are made for a wide range of speeds, horsepower, shaft sizes and can be assembled or disassembled without disturbing the connected machines, except in rare instances.

Write for new Engineering Catalog No. 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

both top and side views. There are cut-outs for the common screwdriver slots, as well as for the Phillips head type. Made of 0.030 in. matte finish plastic, actual size of the template is 5 x 6⅞ in. Rapiddesign, Inc., P. O. Box 592, Glendale, Calif.

For more information— Circle 109, inside back cover

Magnetic Amplifier Regulated Power Supplies

Of wide voltage range, these tubeless d-c power supplies utilize selenium rectifier stacks and magnetic amplifier regulation circuitry with no moving parts or contacts. The unit is rated at 5 to 32 v at 15 amp with a 1 percent regulation over this entire d-c output voltage range, a 1 percent ripple and an 0.2 sec response time. Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.

For more information— Circle 110, inside back cover

Ammonia-Dry White Printer

This 44-in. white printer uses the dry ammonia vapor method of "diazo" reproduction. Operates on 115 v, 60 cycles, ac. Handles cut sheets or roll stock in any length. Synchronized printing and developing speed is up to 14 fpm. Electronic drive provides instant and continuously variable speed change. There is full stop and reversal control for emergency return of originals. Speed dial control automatically changes temperature in evaporating chamber. A 1400 w, thin-type, jacketed quartz lamp is used. Ammonia storage holds up to a week's supply. Simple filler device for odor-free ammonia handling. Dimensions are 60 x 20 x 62 in. high, plus 12 in. feedboard. P&H Sales Corp., 5640 N. Western Ave., Chicago 45, Ill.

For more information— Circle 111, inside back cover

Portable Photocopy Machine

Weight of this unit is 22 lb. It is said to provide up to 90 copies an hour of anything typed, written, printed or drawn up to 9 in. in width by any length. Makes one or two-sided copies. No darkroom is required. This machine makes exposure and then processes.

Interior of unit is stainless steel. It is operated on 110 v ac. Sizes up to 24 in. width will be made. General Photo Products Co. Inc., Chatham, N. J.

For more information— Circle 112, inside back cover

ENGINEERING MATERIALS

High-Finish Aluminum Alloy

Aluminum alloy 5357 (K157), for applications requiring an anodized finish similar to polished chrome plate and stainless steel, is said to lend itself favorably to all mechanical, chemical and electro-chemical finishing procedures. After anodizing, it has particularly high reflectivity characteristics. This high specular finish is also maintained in color anodizing.

The processing of parts made of 5357 follows customary practice involving other non-heat-treatable alloys. A typical sequence of operations is to buff after forming and follow by a mild chemical or electro-chemical cleaning dip, rinse, anodize and hot water seal. Forming characteristics are similar to those of 3003 although 5357 has slightly less elongation in the softer tempers.

Alloy 5357 is readily welded by any of the common methods and it can also be brazed satisfactorily. Properties of the brazed joints will be similar to that of the parent method in the annealed temper.

The nominal chemical composition of 5357 is 0.30 percent manganese and 1 percent magnesium. Typical of 5357 mechanical properties is its tensile strength (psi): in O temper, 19,000; H32, 22,000; H34, 25,000; H36, 28,000; H38, 30,000.

Alloy 5357 is available as flat sheet,

"... cost of the projector will be returned within a three-month period"

CUTLER-HAMMER
MOTOR CONTROL
CH

Tool and Die Dept.

SUBJECT: Report of Savings through use of KODAK CONTOUR PROJECTOR in Tool Inspection

1-This report covers the period from June 1 through 30.

2-During this period, a Kodak Contour Projector was used to check circular form tools; flat drills, taps, and special cutters received from suppliers; and board samples.

3-The following table summarizes direct labor savings in man hours effected by replacing manual inspection with inspection on the Contour Projector. Time required for manual inspection is estimated on the basis of past experience with these parts.

Parts Checked	Direct Labor, Manual Insp.	Direct Labor, Optical Insp.	Savings (In man hrs.)
Circular form tools	350 hours	50 hours	300 hours
Flat drills, taps, special cutters	375 hours	65 hours	310 hours
Board samples	250 hours	90 hours	160 hours
		Total man hours saved	770

4-Without savings cited here, three additional men would have been required for these inspections. In addition, use of the Contour Projector has reduced the possibility of error and resulted in more consistent checking.

5-RECOMMENDATION: Based on the knowledge that these savings can be duplicated each month with present tool room volume, purchase of a second Kodak Contour Projector is recommended. This opinion recognizes the fact we are now checking with one machine only about 40% of all work suitable for the projector. Assuming man hour savings equal to those already effected, cost of the projector will be returned in direct labor savings within a three-month period.

Such reports by users of the Kodak Contour Projector are typical. To find out more about how optical gaging speeds inspection, improves accuracy, write for a copy of the illustrated booklet "The Kodak Contour Projector."

EASTMAN KODAK COMPANY, Special Products Sales Division, Rochester 4, N. Y.

the KODAK CONTOUR PROJECTOR

Kodak

for a better grasp of any fastener problem—

CAMLOC

QUARTER-TURN FASTENERS

MEAN QUICK ACCESS. On panels, doors or covers, Camloc Fasteners provide positive locking by a quarter-turn with a screw driver or wing head. They're vibration-proof, because the action of cam, spring and detent creates a uniform locking torque that grips firmly. Camloc Quarter-Turn Fasteners cost less to install... minimize replacement... fewer do the job.

HEAVY DUTY LATCHES

SAFELY AND EASILY OPERATED. Where high shear-tension capacity is a factor...where opening and closing must be done under heavy loads—Camloc has the answer. Spring-loaded handle, retracting sheer pin, positive locking are among the many design advantages.

SPECIAL PURPOSE FASTENERS

SUITED TO YOUR NEEDS. In the electronics, aircraft, machinery and many other fields, leading original equipment manufacturers are calling on Camloc's Engineering Department to design special fasteners that increase accessibility.

If you have any fastener problem, write for our catalog or specific information.

soon! STRESSED PANEL FASTENERS

A complete departure from conventional fastening. Write for illustrated brochure.

CAMLOC

FASTENER CORPORATION

62 Spring Valley Road, Paramus, N. J.

WEST COAST OFFICE: 5410 WILSHIRE BLVD., LOS ANGELES, CAL.

coil and circles. Maximum width of the flat sheet is 72 in. in the various tempers. Gage ranges from 0.006 to 0.249 in. Coil may be obtained up to 60 in. wide in gage ranges from 0.006 to 0.125 in., depending upon temper. Kaiser Aluminum & Chemical Corp., 1924 Broadway, Oakland 12, Calif.

For more information—
Circle 113, inside back cover

Flexible Paneling For Instruments

Said to be the first flexible plastic sheet for instrument panels, this material is guaranteed shatterproof, nor will it break or chip. It can be bent to any angle or form, to follow the shape of any instrument housing. It has a grained, leather-like and scratch-resistant surface, which does not need further finishing.

This panel material is laminated in layers of two contrasting colors, in a variety of combinations. When engraved through the top layer, the lettering will stand out permanently on a contrasting background and does not need any filling in with paint.

The new flexible sheeting can be sheared, die cut or punched. The material is stain and moisture resistant and has excellent dielectric properties. It is available in various colors in sheets, plates and strips, in thickness of $\frac{1}{32}$, $\frac{1}{16}$ and $\frac{1}{8}$ in. Hermes Plastics, Inc., 13-19 University Pl, New York 3, N. Y.

For more information—
Circle 114, inside back cover

High-Temperature, Glass-Filled Silicone Molding Compound

Parts molded of this glass-filled compound may be pulled hot without cooling the mold. Afterbaking is unnecessary except where parts are to carry a load at high temperatures. Properly molded parts will withstand continuous exposure to 450 F, plus intermittent exposure to as high as 700 F.

Typical properties after molding 10 min at 340 F include a tensile strength of 5,000 to 7,000 psi, a compressive strength of 10,000 to 12,000 psi and an impact strength of 14 to

power in a pillbox

EAD's new miniaturized 1⅛ inch servo-gear motor

For high output torque in a miniature package EAD's tiny servo-gear motor has been designed for applications where size and weight are at a premium.

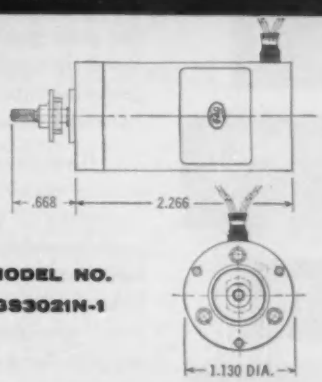
The various RPM and torque combinations are transmitted through precision cut gears mounted in miniature precision ball bearings.

For instant response and maximum torque in a tiny package this gear motor is well adapted for missiles, auto pilots, instrumentation and control devices.

Modifications are available in hysteresis – synchronous and induction designs.

EAD specializes in adapting its designs to meet unusual applications... Tell us your requirement.

Write for our new catalog today!



MODEL NO.
GS3021N-1

CHARACTERISTICS

Input Voltage	115	Stall Torque	7 oz. in.
Phase	2	Rated Torque	3 oz. in.
Frequency	400 cycles	Size	1 1/8" dia.
No Load Speed	180 rpm		2 17/64" long
Full Load Speed	135 rpm	Gear Reduction	28.4
Rotor Inertia	1.25 gm. cm²	Weight	4 1/2 oz.
	Duty	Continuous	

EAD

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

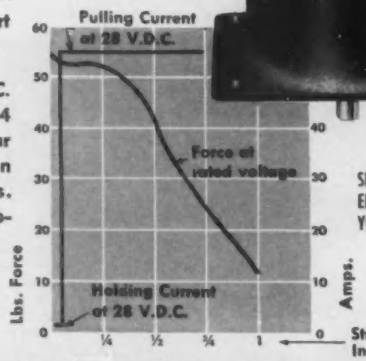
381 CENTRAL AVENUE, DOVER, NEW HAMPSHIRE

Decco DUAL WOUND
D. C. SOLENOIDS

Because of its "Dual wound" construction the new Decco Series 29 D. C. Solenoid is able to deliver tremendous force in small space in continuous service. See Force Stroke Chart below.

This compact, new D.C. Solenoid is available in 24 to 250 Volt range, regular or waterproof construction —J.I.C. Specifications. Ideal for mobile equipment.

Compact
Efficient
Powerful

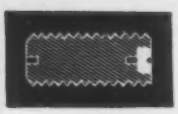


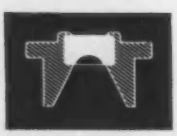
SPECIAL SOLENOIDS ENGINEERED TO YOUR NEEDS

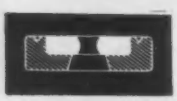
Decco SOLENOIDS

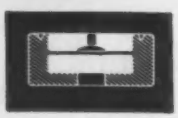
DETROIT COIL COMPANY
2435 HILTON ROAD, FERNDALE 20, MICHIGAN

Bird COMPLETE JEWEL ASSEMBLIES WILL SPEED YOUR PRODUCTION









You'll be time and money ahead if you specify Bird complete jewel assemblies for your product. Rejects are eliminated, jewel breakage is minimized, and Bird jewel assemblies will keep your production running smoothly.

Bird Jewel Assemblies are furnished in the right mounting, rigidly inspected according to your specifications, ready for your assembly operations. Make a test — find out how Bird Jewel Assemblies can help your production. Send us a print of your specifications, and we'll provide samples for your own testing.

Our engineering staff is at your service for all small bearing problems.

Over 40 years of serving industry with Quality jewel bearings

Richard H. Bird & Co., Inc.

Sapphire and glass jewels · Precision glass grinding · Ferrite precision products · Sapphire stylii

1 Spruce Street, Waltham 54, Mass.

22 ft-lb per in. Flexural strength ranges from 12,000 to 14,000 psi at room temperature and 5,000 psi at 392 F.

This compound may be molded with conventional equipment by either compression or transfer techniques. Mold shrinkage ranges from zero to 0.0035 percent. Finished parts may be machined with high speed tools. Dow Corning Corp., Midland, Mich.

For more information— Circle 115, inside back cover

General Purpose Woven Glass Tapes

Applications of this series of glass fiber tapes include wrappings for field coils, armature coils and stator coils in d-c motors and generators, and in a-c induction motors, synchronous motors and generators manufactured for railroads, steel mills, chemical plants, coal and metal mining industries and public utility companies.

Available in all standard widths, from ½ to 1½ in., and in thicknesses of 0.004 to 0.015 in., these tapes are woven in both medium and close weave construction. Hess, Goldsmith & Co., Inc., 1400 Broadway, New York, N. Y.

For more information— Circle 116, inside back cover

Aluminum Alloy For Electrical Bus Conductors

A higher strength alloy for bus conductors, designated 55EC, is described as combining the high strength characteristics of 6063-T6 with conductivity approaching that of EC-H17. Because of its greater structural strength, 55EC is expected to prove useful in applications where short circuit forces are high. The high strength characteristics also provide a more favorable creep rate. Available in many structural shapes and in both rectangular and tubular conductors, the new alloy is adapted to use in panel-boards, switch-boards, bus duct, isolated phase bus and other bus conductor functions.

The alloy may be plated and welded as easily as other aluminum bus conductor materials and bolted electrical connections prove as reliable as those

made with other electrical conductor alloys. Tolerances conform to the present standards for rectangular and tubular bus conductors. Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland, Calif.

For more information—
Circle 117, inside back cover

Glass-Silicone Laminate

Capable of withstanding constant temperatures of 400 F without affecting either mechanical or electrical values, this silicone resin, glass fiber laminate is said to be particularly suited to a great number of electrical and electronic applications where components are subject to high ambient or operating temperatures. It is manufactured to conform to MIL-P-997, type GSG.

Dimensionally stable and combining high mechanical strength with good insulation and arc resistance, the new grade also incorporates high dielectric strength with low moisture absorption. Grade G-7 is available in either sheet form, or as parts fabricated to specification. Synthane Corp., Oaks, Pa.

For more information—
Circle 118, inside back cover

Alloy for General Hard-facing Applications

A chrome-cobalt-tungsten hard-facing alloy for wear and corrosion resistance is available in the form of rod for oxyacetylene torch application. It has been developed to provide a material that is ideally suited to such applications as edger rolls, swaging mandrels, engine exhaust valves and seats, hot-casting stripper bits and such hot-work tools as punches, dies, shear knives and blades. The major advantage in the hot-work applications is the material's ability to hold a good edge.

As deposited by an oxy-acetylene torch, the new material has a hardness of 40 to 44 Rc. Tensile strength is 104,000 psi, specific gravity 8.3, melting point 2325 F. The rods are available in $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$ and $\frac{3}{8}$-in. dia as well as cast form. Wall Colmonoy Corp., 19345 John R St., Detroit 3, Mich.

For more information—
Circle 119, inside back cover

for control of

SHOCK and VIBRATION

Photo courtesy Bell Aircraft Corporation

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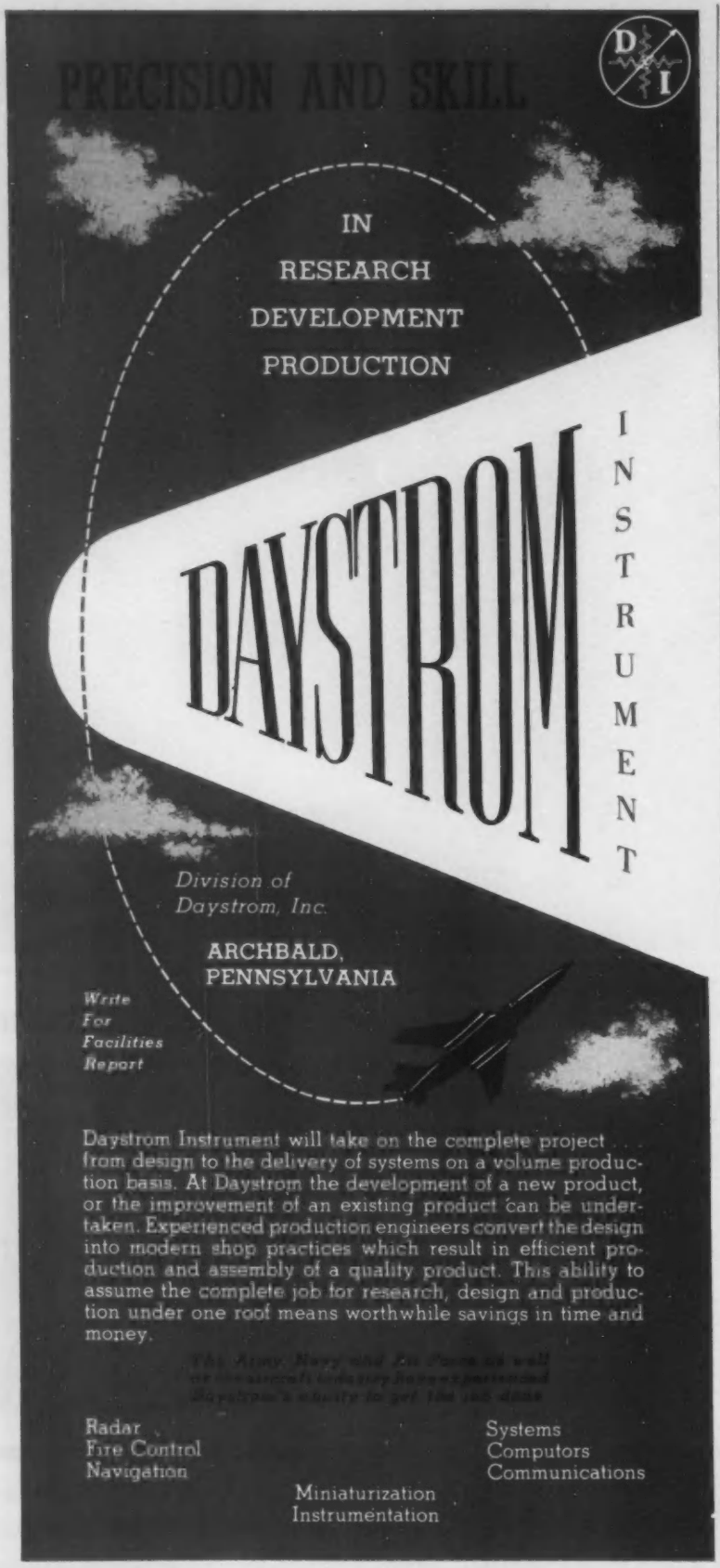

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

Self-Sticking Tapes—Catalog, 20 pp, contains revised and added technical data, descriptions, photos and application information on pressure-sensitive electrical tapes of acetate cloth, acetate film, acetate film-cloth combination, flatback and crepe paper, vinyl film, cotton cloth, glass cloth and "Mylar" polyester film. The self-sticking non-electrical tapes included are of paper, glass fiber reinforced paper, rayon reinforced acetate film, cloth, cellophane, acetate film, plastic, aluminum foil, and adhesive film. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill.

Circle 120, inside back cover

Variable Speed Liquid Drive—Booklet, 8 pp, has a table of capacities dimensions and other data. Liquid Drive Corp., Holly, Mich.

Circle 121, inside back cover

High-Voltage, Glass-Cased Capacitors—Bulletin GC-1, 4 pp, includes explanation of catalog numbers, high altitude application, lead specifications, ripple voltage and engineering specifications. Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle 122, inside back cover

Tungsten—Brochure, 20 pp, devoted to the manufacture, properties, and uses of tungsten. Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

Circle 123, inside back cover

Repeat-Cycle Dial Timer—Bulletin N-80, 4 pp. Photographs, wiring and application diagrams show timer controlling electrically-heated equipment,

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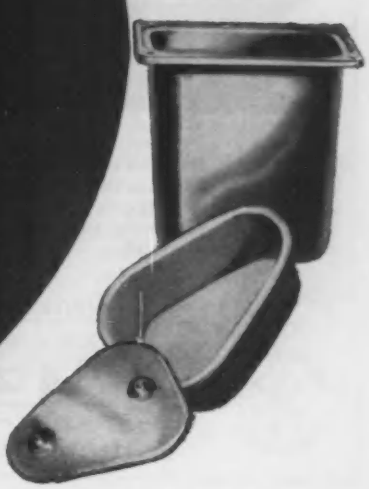

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conveyor drives, solenoid valves, pumps and other processes. Dept. N, Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Pa.

Circle 124, inside back cover

Hydraulic Control Valve—Catalog File 1551A, 10 pp, gives dimensional data on directional valves for mobile equipment applications, covering one, two, three and four-spool models of from 8 to 35 gpm capacity. Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 125, inside back cover

Air-Actuated Clutch—Bulletin 304, 4 pp, describes performance characteristics of the Model PO Clutch, for installation on equipment in oil fields, on cranes and shovels, on presses and brakes, hoists and paper mill drives. Twin Disc Clutch Co., Racine, Wis.

Circle 126, inside back cover

Styrene Molding Compounds—Data sheet, 4pp, contains table of mechanical, thermal, optical, physical, electrical and molding properties and characteristics. Monsanto Chemical Co., Springfield, Mass.

Circle 127, inside back cover

Solution Ceramics—Brochure, 12 pp, describes inorganic coating for metals, asserted to be free from brittleness and to be unusually adherent. Armour Research Foundation, 10 W. 35 St., Chicago 16, Ill.

Circle 128, inside back cover

D-c Contactors—Leaflet C 54-84, 2 pp, describes clapper-type contactors used in controls for heavy duty equipment such as electric trucks, hoists and cranes. Allis Chalmers Mfg. Co., 1002 S. 70 St., Milwaukee, Wis.

Circle 129, inside back cover

Direct-Writing Oscillograph—Booklet, 8 pp, describes a wheeled floor model of this type of recording device. Cutaway drawing shows construction and circuit diagrams are also provided. Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill.

Circle 130, inside back cover

Pneumatic-Actuating Level Control—Leaflet CP2, 2 pp, shows in schematic form how pressure changes can either be used directly to operate a dia-

phragm control valve or can be fed into auxiliary automatic or manual control equipment where the pneumatic valve requires greater air volumes. An application section shows the equipment to be useful in the handling of most non-adhesive chemicals, milk, oils, refrigerants such as ammonia and the "Freons," and all condensed gases over a temperature range from 500 to −425 F. Full specifications are included. Thermo Instruments Co., 1310 County Road, Belmont, Calif.

Circle 131, inside back cover

Hydraulic Aircraft Pump—Brochure 504, 4 pp, describes 3000 psi variable delivery pumps, including sizes delivering from 2 to 10 gpm at 1500 rpm with speeds to 4500 rpm. Large colored cutaway drawing of the pump explains design and functioning of working parts. Information on pressure regulation, lubrication, priming, hydraulic fluid, installation and maintenance also provided. New York Air Brake Co., Starbuck Ave., Watertown, N. Y.

Circle 132, inside back cover

Worm Gear Motors—Catalog 46-C, 67 pp, describes units for horizontal or vertical drive, with ratio range of 5.66:1 to 100:1 and from ⅛ to 30 hp. Rating tables, dimensions, prices are included. D. O. James Gear Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill.

Circle 133, inside back cover

Gear Motor Reducers—Supplement to Catalog 47-C, 4 pp, describes 35 sizes of 10:1 to 1200:1 ratio range and from ¾ to 75 hp. Rating tables, dimensions, prices included. D. O. James Gear Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill.

Circle 134, inside back cover

Threaded Fasteners—Catalog, 32 pp, includes socket screw products, socket head cap screws, self-locking set screws, shoulder screws, flat head socket cap screws, button head socket screws, square head set screws, pressure plugs, ground dowel pins and socket screw keys. Tables detail dimensions of each product. Standard Pressed Steel Co., Box 545, Jenkintown, Pa.

Circle 135, inside back cover

Relay Amplifier—Booklet, 8 pp, provides circuit diagrams and specifica-

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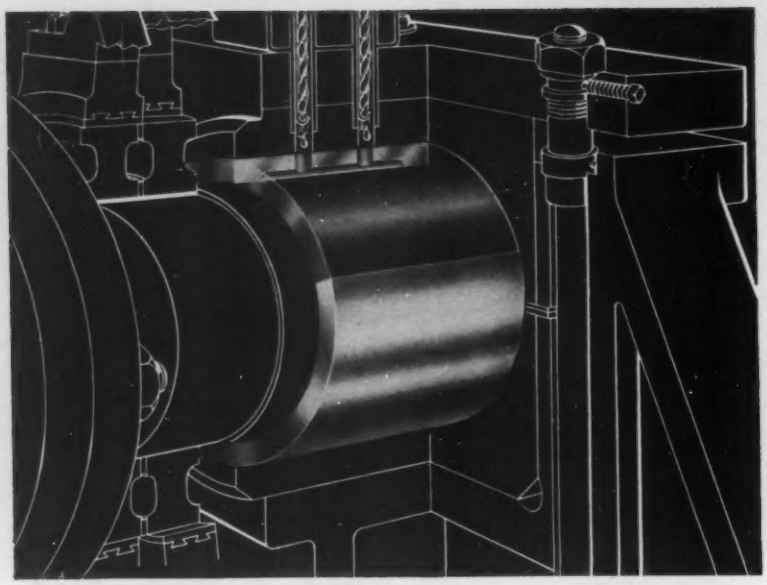

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tions. Goldak Co., 1544 W. Glenoaks Blvd., Glendale 1, Calif.

Circle 136, inside back cover

Temperature Control—Bulletin 104, 2 pp, covers Model D-1S, primarily used for controlling temperatures up to 1800 F, where a wide and easily adjustable range is required. Burling Instrument Co., 16 River Road, Chatham, N. J.

Circle 137, inside back cover

Hand and Foot Valves—Bulletin 303B, 20 pp, describes the valves in detail together with installation data, parts lists and exploded views. Colored air flow diagrams are also provided. Ross Operating Valve Co., Dept. 3104, 120 E. Golden Gate, Detroit 3, Mich.

Circle 138, inside back cover

Aluminum Extrusions—Circular, 12 pp. The extrusion process is explained briefly. The six basic extrusion types are described and illustrated by isometric drawings. Two-page specification table lists physical properties and recommended applications for the 14 most generally used alloys. Also included is a full-page tolerance table listing tolerances of the various types of extrusions. Precision Extrusions, Bensenville, Ill.

Circle 139, inside back cover

Automatic Regulators—Bulletin 2, 4 pp, contains illustrations and descriptive paragraphs on 12 basic control valve types frequently used by the marine and chemical process industries, power generating facilities and for numerous liquid or gas pressure control applications requiring precise instrumentation by means of automatic regulators. Atlas Valve Co., Newark, N. J.

Circle 140, inside back cover

Roller Gear Drives—Catalog 105, 21 pp, presents typical applications, calculation of load requirements, dimensions and capacities of 4, 6, 8, 12, 16, 18-stop models. Ferguson Machine & Tool Co., Inc., P. O. Box 191, St. Louis 21, Mo.

Circle 141, inside back cover

Variable Speed Drive—Bulletin 497, 8 pp, describes single wide-range belt variable speed drive. Shows how to design and select drives for 1 to 20 hp

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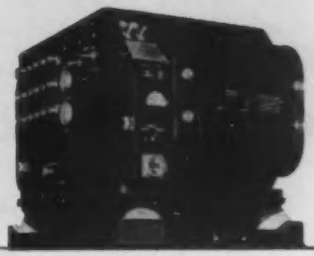

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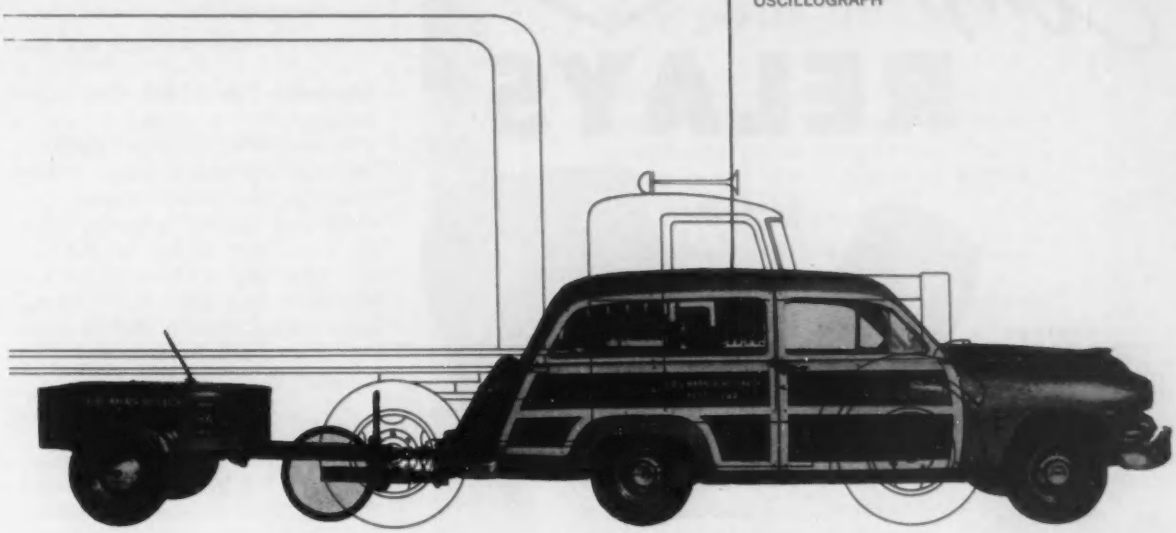

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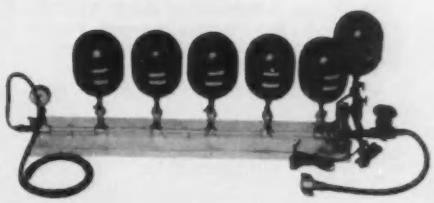

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motors. Dimensions and list prices are included. T. B. Wood's Sons Co., Chambersburg, Pa.

Circle 142, inside back cover

Data Processing Equipment—Bulletin CEC 1301, 12 pp. Photographs, technical specifications and descriptive functional diagrams describing recording oscillographs, galvanometers, amplifiers, power supplies, matching networks, velocity and pressure pickups, vibration meters, oscillogram processors and analog-to-digital converters. Consolidated Engineering Corp., Pasadena 15, Calif.

Circle 143, inside back cover

Adjustable Drives and Couplings—Bulletin GB2, 16 pp, includes adjustable speed drives, liquid and air-cooled couplings and brakes, stationary field couplings, absorption, motoring, universal and variable frequency dynamometers, press drives. In addition, basic principles of eddy-current machinery, torque, heat and operating characteristics, cooling efficiency and control are detailed. Eaton Mfg. Co., Kenosha, Wis.

Circle 144, inside back cover

Heat Treatment of Nickel Cast Irons—Bulletin A-115, 16 pp, 13 charts and 11 tables. How to increase the usefulness of cast irons and improve the properties by alloying and heat treatment. A glossary of terms is included. International Nickel, New York 5, N. Y.

Circle 145, inside back cover

Fluctuating-Pressure Transducer—Leaflet, Form PT654, describes miniature flush-diaphragm strain-gage transducer recommended for applications requiring small size and light weight as well as an arrangement where the sensing diaphragm can be located directly in the surface under pressure to eliminate phase and amplitude errors in fluctuating-pressure measurements. Provides dimensional and construction information in mechanical drawings and gives electrical circuitry. Electronic Engineering Associates, Ltd., 1082 Brittan Ave., San Carlos, Calif.

Circle 146, inside back cover

High Strength, High Temperature Alloys—Pamphlet, 20 pp, provides notes on the uses and characteristics

of some ferritic and austenitic alloys. Tables and charts illustrate properties of these materials, and forms in which they are available. Universal-Cyclops Steel Corp., Dept. 10, Bridgeville, Pa.

Circle 147, inside back cover

Investment Castings—Booklet, 20 pp, explains lost-wax process, its limitations, sizes and weights of parts supplied, tolerances, holes, slots and surfaces, castable metals and alloys and also what to avoid in designs. Comparison of investment casting with other processes is given, along with general ideas of costs and applications. Scott Casting & Mfg., Co., 116 W. Lancaster Ave., Berwyn, Pa.

Circle 148, inside back cover

Stepping Relays—Bulletin, 12 pp, contains illustrations, dimensional drawings, technical chart data and general information on midget, high-speed, vibration resistant and interlock types for add-subtract, continuous rotation, electrical reset and other applications. Guardian Electric Mfg., Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle 149, inside back cover

Titanium Foil—Bulletin 100, 2 pp, describes commercially pure titanium foil now being produced. It gives mill limits, tolerance chart, composition of commercially pure grade titanium foil, mechanical and electrical properties. Also includes data on welding, brazing, annealing and forming of this material. American Silver Co., Inc., 36-07 Prince St., Flushing, N. Y.

Circle 150, inside back cover

Motor-Generator Sets—Brochure P 400-54, 6 pp, describes and illustrates 400 cycle sets, in ratings from 5 to 100 kw. Detailed specifications are provided and included are photographs of oscillograms showing voltage recovery and stability, output voltage wave form, a harmonic content analysis chart and cutaway showing salient construction features. Palmer Electric Mfg. Co., 6629 Bear Ave., Bell, Calif.

Circle 151, inside back cover

Electrical Switches—Catalog 80A, 127 pp, pictures and describes deadfront, tap, knife units and accessories, including various modifications. Drawings and tables give dimensions. Combined index for various parts of catalog

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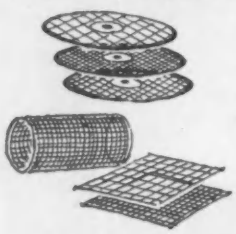

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Catalogs and Bulletins.....continued

included. Barklew Electric Mfg. Co., Middletown, Ohio.

Circle 152, inside back cover

Toroid Coils—Folder, 4 pp, describes general characteristics and includes specification charts and standard case styles. Hycor Co., Inc., 11423 Vanowen St., N. Hollywood, Calif.

Circle 153, inside back cover

Leaded Alloy Steel—Bulletin 14-5, 8 pp, describes "Rycut 40", said to be the fastest machining alloy steel in its carbon range (0.40 carbon). Included are case studies showing machining comparisons, increased production and typical savings in cost of machined parts. Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80, Ill.

Circle 154, inside back cover

Voltage Regulator—Bulletin T-8400, 4 pp, describes and illustrates an all static voltage regulator for 400 cycle, a-c machines. Specifications on construction, installation and operating characteristics are included, along with photographs of oscillograms showing voltage recovery and stability, output voltage wave form. Leach Corp., 4441 Santa Fe Ave., Los Angeles 58, Calif.

Circle 155, inside back cover

Electric-Mechanical Governor—Bulletin T-8500, 4 pp, describes and illustrates a load sensitive governor. Construction features, operating characteristics, models and applications are provided as well as photographs and schematics. Leach Corp., 4441 Santa Fe Ave., Los Angeles 58, Calif.

Circle 156, inside back cover

Electron Tube Clamping Shields—Catalog, 10 pp. Miniature and subminiature tube shields are illustrated and keyed to appropriate dimensional engineering drawings. International Electronic Research Corp., 177 W. Magnolia Blvd., Burbank, Calif.

Circle 157, inside back cover

Cast Monel—Booklet, 7 pp, describes engineering properties of cast Monel, a nickel-copper alloy containing about two-thirds nickel. International Nickel, 67 Wall St., New York 5, N. Y.

Circle 158, inside back cover

Caps and Filler Necks—Booklet, 12 pp, contains engineering data on caps

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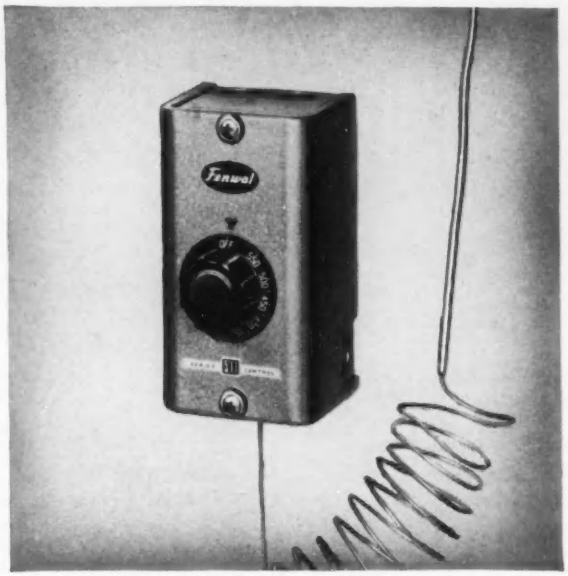

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and related necks for fluid tanks, radiators, oil filters, automobiles, trucks, prime movers, tractors, construction machinery, air compressors, power mowers and similar equipment. Eaton Mfg. Co., 755 E. 140 St., Cleveland 10, Ohio.

Circle 159, inside back cover

Fiber Parts and Materials—Catalog, 36 pp, describes fibre sheet, board, rods, tubes, stamped parts, paper. Spaulding Fibre Co., Inc., 585 Boylston St., Boston 16, Mass.

Circle 160, inside back cover

Manganese Steel Chain—Bulletin, 8 pp. Photographs of each type of chain are accompanied with detailed drawings and tables giving complete specifications. Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

Circle 161, inside back cover

Centrifugal Castings—Chart provides compositions, properties, specification numbers of both ferrous and nonferrous centrifugal castings. Sandusky Foundry & Machine Co., Sandusky, Ohio.

Circle 162, inside back cover

Molded Fabric Bearings—Brochure, 32 pp, illustrates applications and describes properties of fabric bearings, wear plates and other parts. Shows bearings made for grease or oil-lubricated, water-lubricated, unlubricated and acid resistant service. Also includes molded asbestos brake blocks, frictions, cones and other shapes. Gatke Corp., 226V N. LaSalle St., Chicago 1, Ill.

Circle 163, inside back cover

Variable Ratio Transformer—Brochure, 6 pp, explains construction and operation of a device said to combine the resolution and linearity associated with multi-turn potentiometers with the low output impedance characteristic of variable auto-transformers. Included are performance curves, application schematics in computer and servo systems, specifications of the 60 and 400 cycles per sec and drawings, illustrating mode of operation. Perkin-Elmer Corp., Norwalk, Conn.

Circle 164, inside back cover

Plug Valve Actuator—Bulletin, 8 pp, is illustrated with photographs of typical

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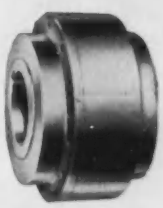

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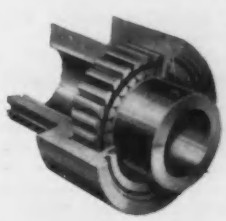

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installations and detailed line drawings. It gives complete engineering data as well as information on how the actuators are used. Pantex Mfg. Corp., Pawtucket, R. I.

Circle 165, inside back cover

Sub-Miniature Relay—Bulletin GEA-6211, 4 pp, gives information on this hermetically sealed relay's performance features, construction, and operation. Size is illustrated with photographs and dimensional drawings. General Electric Co., Schenectady 5, N. Y.

Circle 166, inside back cover

Solenoid Contactors—Bulletin SC-9, 8 pp, describes enclosed and sealed models with power ranges up to 250 amp. Includes dimensional drawings, technical data, military specification numbers, type numbers and specific approval information. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.

Circle 167, inside back cover

Valves—Catalog, 24 pp, covers jet engine components and engine primers as well as hydraulic, pneumatic and other check valves and plug, on-off, angle needle, selector and restrictor valves. Charts in each section detail sizes and engineering data of the various products offered. A special table describes the lubricants the company recommends for servicing of plug valves. Kohler Co., Kohler, Wis.

Circle 168, inside back cover

Constant-Speed Motor—Form SC-23, 2 pp. Performance curves are included giving data on output watts, speed, efficiency and input amperes plotted against torque output. Dalmotor Co., 1362 Clay St., Santa Clara, Calif.

Circle 169, inside back cover

Oil-Retaining Bronze Bearings—Stock List 4, 20 pp, lists flange, sleeve and thrust bearings, together with cored and solid bar stock; provides information on application, installation, lubrication, machining. Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

Circle 170, inside back cover

Stainless Steel Piping—Bulletin TB-356, 6 pp, outlines methods of bending and joining stainless pipe and discusses the problem of light wall versus heavy wall pipe. Also included is a table of dimensions and weights of

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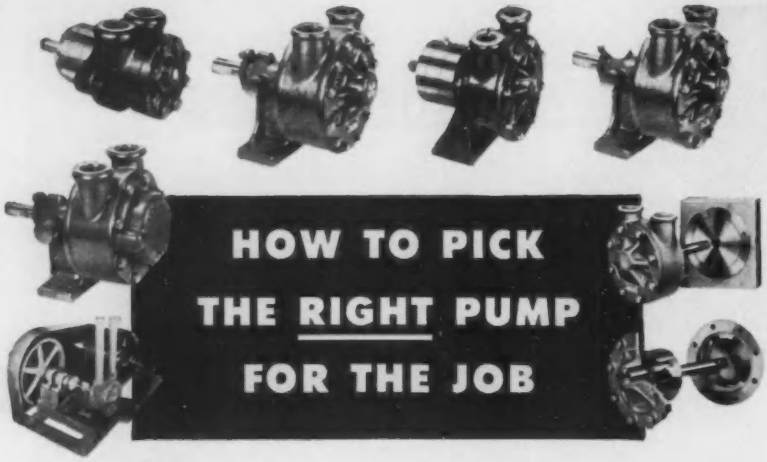

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		Catalog No.
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Model C	2 to 200 g.p.m. up to 100 p.s.i.	102
Model R	¾ to 200 g.p.m. up to 100 p.s.i.	105
Models S & SA	⅓ to 200 g.p.m. up to 200 p.s.i.	106

For HYDRAULIC SERVICE

		Catalog No.
Model L	⅓ to 6 g.p.m. up to 600 p.s.i.	101
Model CK	5 to 200 g.p.m. up to 400 p.s.i.	103
Model R	¾ to 200 g.p.m. up to 400 p.s.i.	105
Models S & SA	⅓ to 200 g.p.m. up to 200 p.s.i.	106

For COOLANT SERVICE

		Catalog No.
Model C	2 to 200 g.p.m. up to 100 p.s.i.	102
Model CK	100 to 200 g.p.m. up to 200 p.s.i.	103
Model M	2 to 50 g.p.m. up to 15 p.s.i.	104
Model R	2 to 200 g.p.m. up to 100 p.s.i.	105
Models S & SA	2 to 200 g.p.m. up to 200 p.s.i.	106

For TRANSFER AND CIRCULATING

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Model C	2 to 200 g.p.m. up to 100 p.s.i.	102
Model CK	100 to 200 g.p.m. up to 200 p.s.i.	103
Model R	2 to 200 g.p.m. up to 100 p.s.i.	105
Models S & SA	2 to 200 g.p.m. up to 100 p.s.i.	106

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Type SU	2 to 50 g.p.m. up to 300 p.s.i.	107

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various pipe size schedules. Condensed technical data on mechanical and physical properties of the more popular stainless steels used for piping is provided. Babcock & Wilson Co. Beaver Falls, Pa.

Circle 171, inside back cover

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

Packings—Selector shows packing styles and pressure and temperature readings for four types of packing application, gaskets, valves stems and centrifugal and reciprocating pumps. New York Belting & Packing Co., 1 Market St., Passaic, N. J.

Chain—Catalog, 16 pp., gives size, metal thickness, approximate links per foot, link width, approximate tensile strength and shipping weights in tabular form for sash chain, sash chain attachments, single and double jack chain, safety chain, plumbers' link chain, navy link chain, furnace chain, register chain, double loop coil chain, ball chain and accessories, ladder sprocket chain, single loop chain, welded chain, universal chain. Risdon Mfg. Co., Naugatuck, Conn.

Wire and Cable—Catalog C-79, over 1,000 pp. Section headings include: bare and coated wire and cable, weatherproof wire and cable, building wire and cable, miscellaneous wire and cable, rubber and plastic power cable, portable cords and cables, paper-insulated power cable, varnished-cambric wire and cable, communication wire and cable, magnet wire, potheads and terminals, solder-sealed potheads, and accessories for wire and cable. Conductor materials, insulation materials, coverings and miscellaneous data on materials follow: An engineering data handbook concludes the new catalog.

All sections are indexed and profusely illustrated. All forms of magnet wire are treated; round, square and rectangular. Concluding portion of the section on magnet wire contains all relevant information on formulate, trigonometric functions, some helpful recommendations on packaging, storage and handling, effect of humidity. Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.

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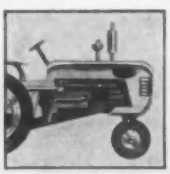

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Ad Libbing by the Editor

One of the greatest difficulties is the conveyance of thoughts and ideas by the written word. This is strikingly illustrated by the endless number of ambiguities, doubts and conflicts that appear in the written laws. Hundreds of thousands of lawyers sweat out their living by arguing over them. And the Supreme Court will spend weeks deliberating over the intent of a painstakingly written law. Much of the confusion can be traced to failures to use exactly the correct word or to confusing shades of meaning.

Mistakes versus Error

Many people use the words "mistake" and "error" interchangeably. Usually that does no great harm. In some respects it is like getting mixed up in the use of the words "shall" and "will," which is something that almost everybody does indiscriminately, myself included. But a confusion of the words "mistake" "blunder" and "error" can well lead to a serious situation.

Scientists and engineers talk frequently about "errors of observation," "instrument errors" and other kinds of "accidental errors." And it can be proved that such errors will average out, but only so if they are accidental errors and not mistakes or blunders. Therein lies the fundamental difference between an error and a mistake. Errors average out; mistakes cannot.

In making a survey, the investigator included samples that were not legitimate. The data obtained from the illegitimate samples was mixed in with all the other figures obtained and then run through the tabulating machines. Not till then was it discovered that mistakes had been made in the selection of the samples. When his attention was called to this fact the researcher glibly replied, "That is nothing to be concerned about. Errors average out."

Unfortunately, the selection of the wrong samples was not an error, it was a blunder. If the data obtained from the improper samples had been omitted from the tabulation the final answer would have been quite different. On the other hand, the average of any large number of properly made readings of the same measured quantity, though each reading involves on accidental error, will be closely the same. But if one group of such readings includes some that were made or recorded mistakenly, the average might be considerably different.

Learning versus Forgetting

And that brings up another thought, namely, learning and forgetting, and the relationship between them and knowledge.

When a baby is born it is totally unable to forget anything because it knows nothing. But very quickly it learns and in a few years it has amassed a sizeable fund of knowledge. Then the forgetting begins, but not fast in those early years.

At the end of each year the amount of knowledge gained is the difference between what has been learned that year and what has been forgotten that year. After the first few years the rate

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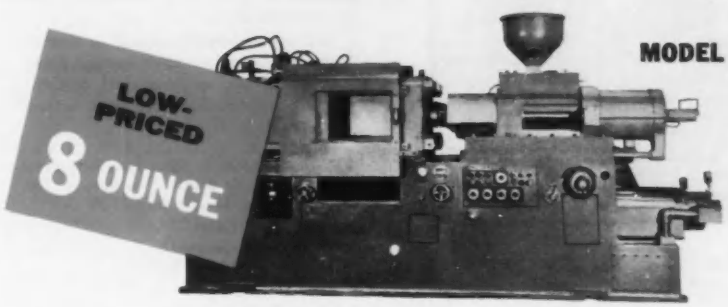

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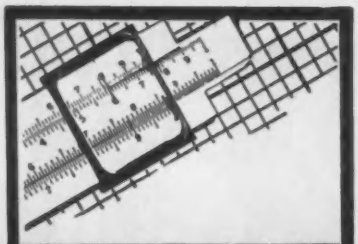

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of learning drops considerably and then levels off, where it remains for an indefinite number of years, depending on the amount of exercise the brain gets. More brains rust out than wear out.

There comes a time, quite early in some lives and quite late in others, where the curves of learning and forgetting cross. From then on, each year the person forgets more than he has learned. His fund of knowledge steadily decreases until it is no more in amount than what he knew in his early youth. He has arrived at his second childhood.

It has been quite well established that the ability to learn diminishes more slowly with age than does the ability to remember. Forgetfulness grows with advancing years but if the person wishes to apply himself he can accumulate more knowledge each year than the amount he forgets. A healthy individual is never too old to learn and if he applies himself he will grow each year in knowledge and stature. One should never give his brain a chance to rust out. –G.F.N.

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NEW BOOKS

Compressed Air Handbook

Compiled by the Compressed Air and Gas Institute. 6 x 9 in., 384 pp. Published by the McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. $8.

This second edition—with many new illustrations, charts and tables—features information on recent advances in displacement-type compressors and recently developed maintenance techniques. Also, information presented in the first edition has, in some instances, been revised or changed to keep up with advancements in the field of compressed air. All of the material has been developed and prepared by various groups and individuals of the Compressed Air and Gas Institute, in collaboration with the Institute's Educational Committee.

The information presented has been compiled to meet the reference needs of users and prospective users of this basic pneumatic equipment, and the data cover the theory, selection, application, installation, testing and maintenance of this equipment. Supplementing such data, this handbook includes extensive practical case-study information accumulated in the Institute's 12-year program of obtaining on-the-job detailed and illustrated case-history reports in factories, on construction projects, in commercial establishments, in shops, plants and elsewhere.

The first section deals with typical applications of compressed air and gas. Some 50 different industries are covered. At the end of the chapter is a partial list of possible applications of compressed air which have been met and for which machines have been applied in these various industries.

The 83-page second section is divided into two parts: (1) air-operated portable tools and accessories; and (2) air-operated rock drills and accessories. The various portable tools are discussed as well as couplings and air hose fittings, and tool care. The larger rock

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drills are similarly discussed with additional information on pumps, line oilers, drill testing and the number of tools that can be operated from various size compressors.

Section three—The Compressor-Air System—is concerned with compressor installation, capacity and equipment. Such factors as the number and location of compressors; regulation and distribution of air; causes, effects and remedies of low pressure; and compressor accessories, are explained and discussed.

Sections four and five deal with compressor types, installations and fields of application. All types of positive-displacement and dynamic-type blowers and compressors are covered.

The final section sets up engineering data and test procedures for the compressors. Included are tables, charts, formulas and other necessary information to completely define the capacity and performance and to test a unit.

Although basic in approach, the book is a comprehensive, practical guide giving a wealth of descriptions, data and pointers for best results in using compressed air power in a wide variety of industries.

Automatic Production of Electronic Equipment

Proceedings of symposium on Automatic Production of Electronic Equipment sponsored by the Stanford Research Institute, Stanford, Calif., and the United States Air Force. 8½ x 11 *in.*, 119 *pp, paper-bound. Available from Stanford Research Institute, Public Relations Office, Stanford, Calif.* $4.

This Symposium was conducted "to promote collective thinking and cooperation of material processors and manufacturers of electronic components, equipment and automatic machinery" toward ways of reducing costs, increasing output and simplifying but improving methods of inspection and quality control. The talks presented at the Symposium and the general panel discussion which terminated the meetings are reproduced in these Proceedings.

There are 17 papers in all, well illustrated by sketches, graphs, charts and photographs. Subjects covered in-

clude: (1) general aspects of automation; (2) product design, construction techniques, materials, and components; and (3) design of automatic production lines.

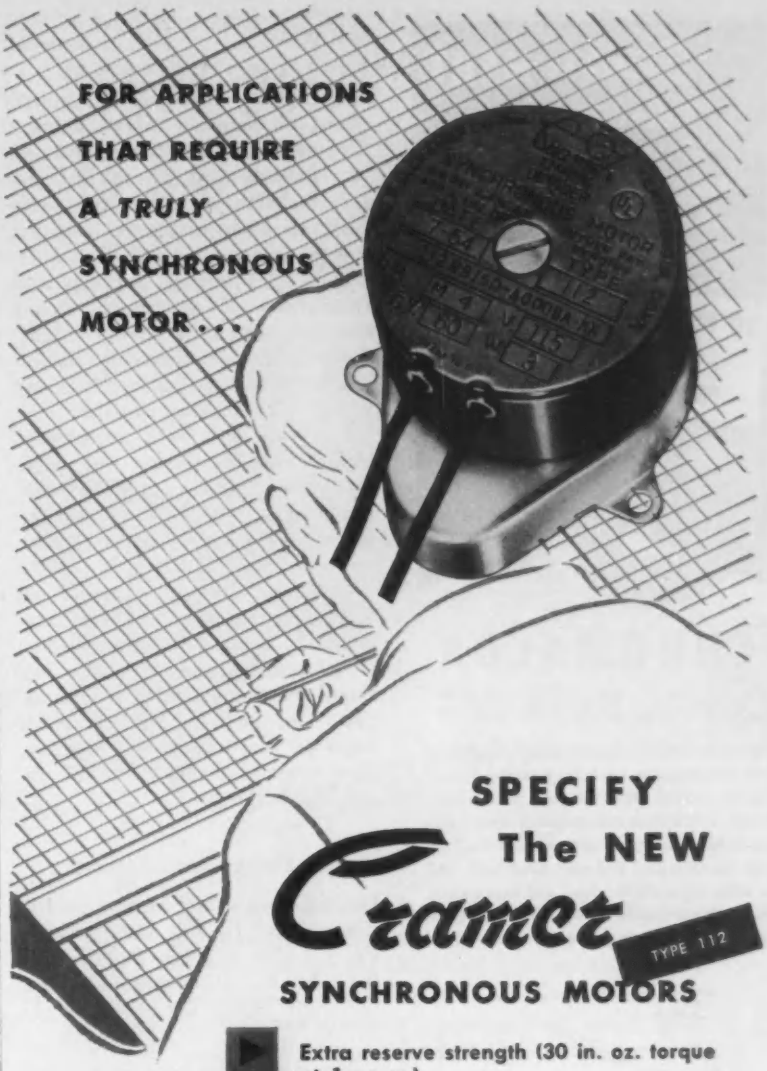
The titles of papers presented are: The Impact of Automatic Control on Industry; The Anatomy of Production Automata; Keys to Successful Management of the Automatic Factory; The Importance of Coordination in a Cooperative Program; An Approach to Automatic Production of Electronic Equipment; A Look Into the Future of Automatic Production of Electronic Equipment; Mechanical Assembly of Electronic Components; A Receiving Tube Mount Designed for Automatic Assembly; Automatic Production of Audio Transformers; Mechanized Assembly of Electronic Components; Economics of Automatic Production Equipment from the Machine Designer's Point of View; Operator Convenience and Automatic Safeguards Applied to Automatic Electronic Fabrication; Project Mini-Mech; Control Planning and Methods; and Adapting Present Machine Tools for Automation.

Modern Physics For the Engineer

LOUIS N. RIDENOUR, *Vice-President, International Telemeter Corp., and Visiting Professor of Engineering, University of California.* 6 x 9 in., 499 pp. *Published by the McGraw-Hill Book Co., Inc.,* 330 West 42nd St., New York 36, N. Y. $7.50.

This book is a collection of lectures of an extension course of the same name, delivered at the University of California, 1952-1953. It is intended to familiarize scientists and engineers with some of the most important current advances in physics on the theory that the physics of today is the engineering of tomorrow. The book contains articles by Royal Willer, H. P. Robertson, Leonard Schiff, Frederick Seitz, Charles Kittel, W. D. Hershberger, William A. Fowler, R. V. Langmier, Glenn T. Seaborg, W. K. Panofsky, Jesse Greenstein, David T. Griggs, Roger Revelle, Leonard B. Loeb, Walter Bleakney, Simon Ramo, John Bardeen, J. B. Wiesner and Louis N. Ridenour.

The chapters of this book are ar-



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Part two deals with astrophysics; high-pressure phenomena with applications to geophysics; the earth beneath the sea; lightning and thunderstorms; and transient phenomena in supersonic flow.

Part three discusses electrons and waves, semiconductor electronics, communication theory and transmission of information, and computing machines and the processing of information. This book is recommended for engineers who wish to review in one book recent basic advances in the several fields outlined.

Cams—Design and Layout

LOUIS KASPER, *Chief Mechanical Engineer, Steel Heddle Manufacturing Co. 5 x 8 in., 101 pp. Published by the Chemical Publishing Co., Inc., 212 Fifth Ave., New York, N. Y. $3.50.*

This is a practical book dealing with the various types of cams, their applications, and non-mathematical methods of determining their motion. The examples of design and layout have been selected with some care to cover all those cases which occur most frequently in industrial uses. For any of the more specialized types of motion, the book would be of little value.

Types of cams and cam followers are covered generally in the first chapter. Cam design and layout is dealt with in a general manner in chapter two. Since these two chapters use only seven pages, the material is almost of a pure introductory nature.

Chapters three through eight deal specifically with the different cam types, applications, design and layout. Reciprocating cams are discussed in chapter three and examples shown for several types of motion. Chapter four covers rotating cams and the motions that can be produced; chapter five,

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See pages 28-29

cylindrical cams; chapter six, wiper and rocker cams and rolling levers; chapter seven, rectangular motion cams; chapter eight, sleeve cams; and chapter nine, miscellaneous cam applications.

The last chapter, ten, shows some of the calculations that may be made but these are only applicable to cases where the follower travels on a straight line passing through the center of rotation. Discussed are pressure angle, velocity, displacement and acceleration.

Strength and Resistance of Materials

JOHN M. LESSELLS, *Pres., Lessells & Associates, Inc., Boston, Mass., Assoc. Prof. of Mech. Engrg., Emeritus, Mass. Institute of Technology.* 6 x 9 *in., 449 pp. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.* $10.

The design of machine elements is now based on analytical methods involving advanced theory. These methods, however, are valid only when supported by information on the manner in which engineering materials behave under applied stress. The stated purpose of this volume is to provide the information on the behavior of metals under stress as it has been revealed by observers in this field.

In the first chapter the tensile test, which will always be a very important mechanical test in the acceptance of materials, is reviewed. The chapter includes some of the new concepts resulting from recent research on true stress-strain characteristics.

The book goes on to discuss the mechanism of overstrain and the modifications produced in the tensile-test properties by cold drawing. Hysteresis effects are considered, and residual stresses are briefly reviewed in their relation to overstrain. A discussion on the short-time, rupture and creep tests of carbon and alloy steels as well as gas-turbine superalloys brings into focus the expected behavior of these metals at high temperature applications.

The engineering significance of high energy-absorbing capacity in structural elements subjected to impact is described along with the underlying reasons for the adoption of the

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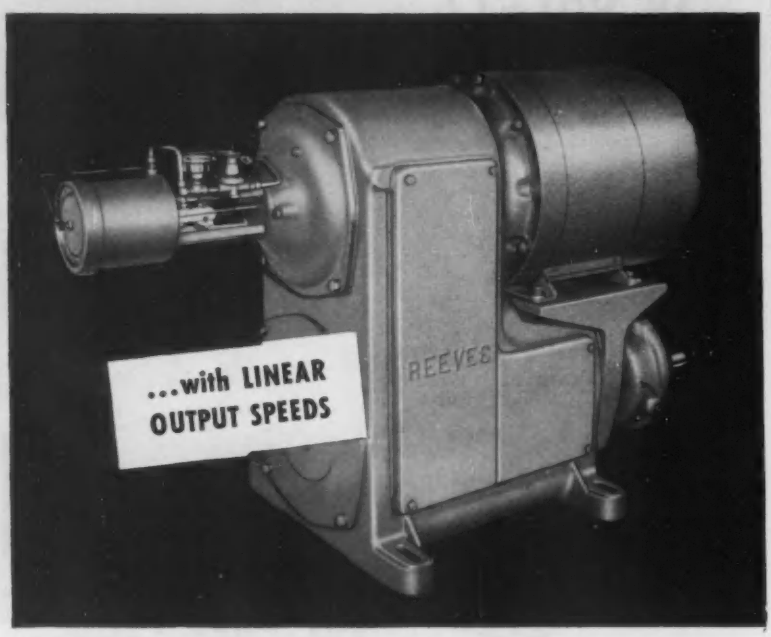

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notched-bar impact test and the fracture test as a means of material control. Because fatigue accounts for the majority of engineering failures, this phenomena is thoroughly explored. A very important part of this discussion is an examination of actual fatigue failures drawn from laboratory tests and service installations. The author follows this with a chapter on strain hysteresis so that the reader may have an approach to a better understanding of fatigue.

The closing chapters of the book are devoted to mechanical wear and the more important theories of strength and working stresses. The book has a number of illustrative problems which should prove helpful to the student. Practicing engineers will find this presentation of applied advanced theory a helpful refresher on the mechanics of materials.

Methods of Reasoning

P. D. SCOTT. *Booklet, 16 pp. Published by the Cleveland Engineering Society, 2136 East 19th St., Cleveland 15, Ohio, $1.*

This booklet is the practical application of the tools of the scientific method to the everyday problems of industry and engineering. It is the first practical approach to be written specifically so that the layman as well as the technical person can quickly grasp the principles and apply them to their daily difficulties. For the engineer, it gives a new slant and a refreshing review of some vital principles he may have forgotten.

The scope in which this work falls is basic to our way of life because it deals with the means of securing agreement, reaching decisions, assuring cooperation and even more important, meeting problems head on with confidence of reaching a sound conclusion.

Starting from the basic thought of what is reasoning, the booklet proceeds in a clear manner through easily assimilated steps covering the concept of the sensed difficulty, techniques of establishing the problem and how to state the approach and the method of arriving at sound solutions.

Among its many interesting chapter headings are: "Who Thinks?," "What Thinking Is," "What Meaning Means," and "What Is So."

ENGINEERING ABSTRACTS

Ultrasonic Soldering Of Aluminum

Abstracted from "Ultrasonic Fluxless Soldering Techniques," by Glenna S. McWhirter, *Welding Engineer*, September 1954.

Although ultrasonic soldering of aluminum has been theoretically possible for some years, it has only very recently been taken from the laboratory to the production stage. Not only aluminum, but copper, silver and magnesium can be soldered by ultrasonic equipment now being built.

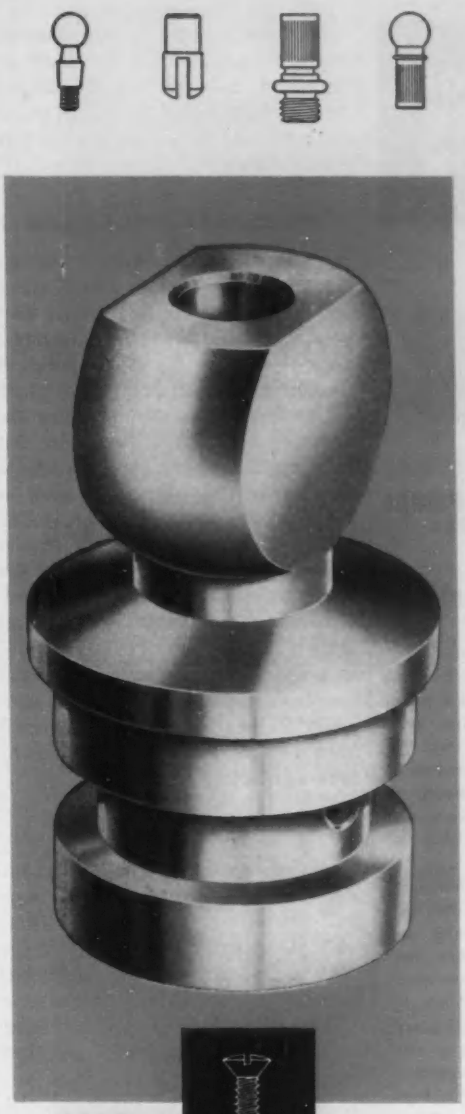
According to Aeroprojects Incorporated, of West Chester, Pa., who manufacture the equipment, fluxless soldering offers these important advantages: (1) Since no flux is used, there can be no excess flux remaining to contribute to corrosion; (2) it eliminates the need for a thorough and often costly washing operation; and (3) the joints are free of contaminants left by flux residue. The last advantage is particularly important when a tight seal is desired.

Done by Magnetostriction

Although heat is necessary to melt the solder, high-frequency vibratory energy is also employed to assist soldering. It is done mainly by magnetostriction. When nickel is magnetized, a microscopic change in its dimensions occurs. The magnetic field is created by a high-frequency alternating current. As the magnetic field goes on and off thousands of times per second, the object is continually losing and gaining length. If the end of the nickel is placed in physical contact with another surface, it transmits a series of extremely rapid vibrations in the ultrasonic range into the other surface.

The soldering head has a powerful magnetostrictive transducer-coupling, which produces ample ultrasonic energy to break down even heavily oxidized surface film on aluminum. The power of the equipment is sufficient to tin heavily anodized, iridized or alodized surfaces.

Soldering heads can be made in



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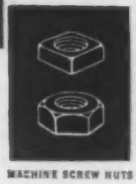
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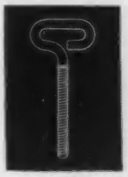
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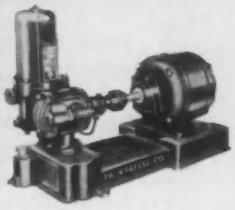

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various sizes and changed to meet different requirements. Pilot plant experiments have developed soldering heads from ¼ in. up to 6 in. in width. Both flat and curved surfaces can be readily tinned.

Preheating of Parts Required

Because of the vibratory energy, parts do not require any special cleaning before soldering. However, they must be heated to a temperature slightly above the melting point of the particular solder being used. Heating is done on a platen below the soldering tip. After the solder has been applied to the heated surfaces, the tip of the ultrasonic head is brought into contact with the molten solder. The intense vibratory activity removes the oxide film and allows the solder to alloy with the base metal. Generally, a soldering job is accomplished in about five to ten seconds.

A wide variety of soldering alloys can be used. Tin, zinc, lead, cadmium, indium and aluminum have all been used in varying compositions to form satisfactory solders.

Applications

High-strength soldered joints for aluminum die castings open up new and interesting possibilities. Ultrasonic soldering gives the product designer a greater opportunity for the use of these low-cost parts.

Dissimilar metals can also be joined by fluxless soldering. As a practical example, copper or silver plates can be joined to aluminum bus bars. The cost saving of aluminum over copper in the electrical field has been overshadowed by the connection problem. Ultrasonic soldering can be of considerable assistance in many cases.

Large areas and heavy sheet or plate can be joined together and to extrusions by ultrasonic soldering.

Altogether, a wide variety of materials can be handled in a large number of sizes and shapes. The equipment is said to be simple to operate and to require no particular skill on the part of the operator.

How the Equipment Works

The equipment consists of two parts: a soldering head and a high-frequency generator. The generator is an electronic device, which takes

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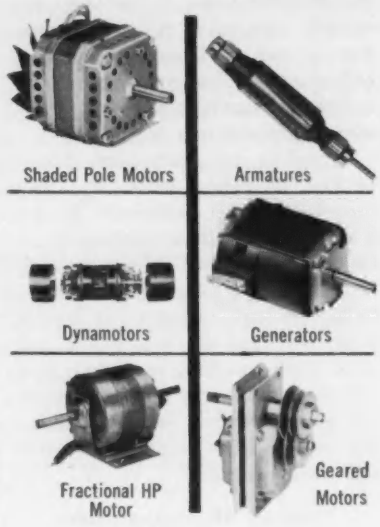

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regular 60-cycle current and converts it to 20,000 cycles-per-second impulses. The converted current is then delivered to the stack in the soldering head.

This stack is made of laminated nickel sheet, which moves about a mil or 0.001 in. up and down with each change in its magnetic field—20,000 times a second. This vibratory energy is transmitted to the soldering head, which is thus able to rip up the oxide coating on the workpiece and assist the solder to alloy with the base metal. A metallurgical bond is formed between the solder and the aluminum workpiece. By exposing samples to the ultrasonics for long periods of time, it is possible to dissolve considerable amounts of aluminum into the solder alloy.

The workpiece is held on an electrically heated flat platen during the soldering operation. Maximum operational temperature of the present unit is 800 F, but a unit that will work at 1,200 to 1,400 F is under study.

Combined Magnetic Brake And Clutch Control

Abstracted from "Application Highlights of Warner "Electric Motion Control," by John Brown, Sales Engineer, Warner Electric Brake & Clutch Co., Beloit, Wisconsin; presented at the AIEE Conference on Machine Tools, October 25-27, 1954, Detroit, Michigan.

Electric motion control implies precise mechanical movement introduced by electromagnetic power efficiently and forcibly exerted for actuation of disk brakes and clutches.

The two basic clutch or brake components are an annular-shaped magnet and a segmental armature with mating friction surfaces. When the magnet coil is energized, magnetic force pulls the armature against the friction face of the magnet, creating braking or clutching torque. It is instantly released when de-energized. The clutch differs from the brake only in added collector rings which bring current to the rotating magnet.

The clutch-brake combination unit is a compact assembly of the standard clutch and brake with many of the interchangeable components common to both and easily adapted to existing power transmission and machine components. These units offer distinct advantages in operation: (1) Fast opera-

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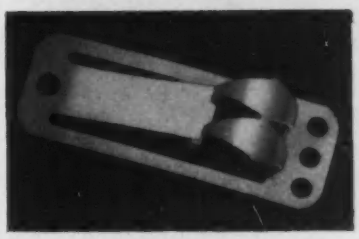

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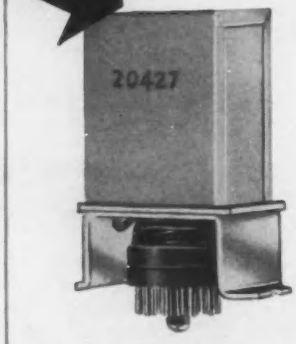

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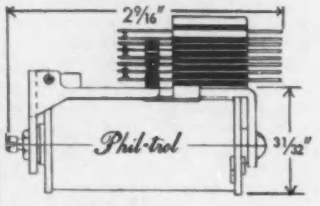

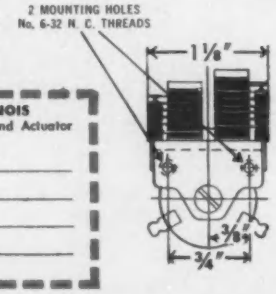

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tion—no mechanical shifting but electric switching from clutch to brake and full torque developed in less than 0.010 sec; (2) shockless—backlash of system is absorbed as torque is increased; (3) high heat dissipation—construction of armature circulates air, reducing temperature and wear; (4) torque-limiting adjustment—automatically with d-c adjustable resistor, proportional to voltage; and (5) automatic wear adjustment—self-compensating.

The foregoing characteristics have been well utilized in automatic equipment using electric motion control for braking, clutching, reversing, rapid cycling, tensioning, positioning, indexing and synchronizing. These are the general applications which will be highlighted.

In applications of these electromagnetic clutches and brakes, acceleration and deceleration rates can be infinitely varied, torque application is smooth and shockless, and mounting is simple and compact.

These clutches provide accurate torque overload protection. Static or holding torque is proportional to the input voltage and permits remote resistor control or drive torque in a power train. Many conveyor systems incorporate a two-voltage clutch control to smoothly accelerate with high torque and protect against overload by time-delay relay switching to reduce voltage.

Continuous reversing can be accomplished with motion control. Two clutches are used to alternately select the forward or reverse drive gears. The rate of change of direction is infinitely adjusted by remote control rheostats, and controlled dwell is achieved by timing switches.

As production demands increase, the importance of faster cycle rates confront the machine designer. The ultimate in cycling, timing and synchronizing is possible with the electromagnetic clutch-brake combination. The elemination of mechanical shifting has resulted in fast cycle rates—20 complete starts and stops per second have been achieved. There is little practical usage for that rate, but many special machines utilize up to six cps.

With electric motion control, it is possible to position both rotating or linear movements. The clutch-brake combination is mechanically or electrically biased to nearly eliminate lost

motion and increase locating accuracy. Under relatively ideal conditions of balanced loads and fairly constant machine friction, the brake positions within plus or minus two degrees of a required stopping point. This range of error may be realized on the input shaft of a gear reduction, but it is proportionately decreased at the output shaft. With direct cam-switching and positioning, error is nonaccumulative.

Machine designers have utilized other positioning functions of electric motion control such as accurate crank movement, cam locating, conveyor positioning and mechanical indexing.

Electric brakes and clutches were initially adapted to mechanical indexing devices such as Geneva wheels, roller-gear and cam drives, and roller-chain and linkage carriages. A clutch or clutch-brake combination has been responsible for stopping the driving members within the range of mechanical dwell. The smooth, shockless engagement of the clutch and deceleration of the brake added many hours to the life of the machine.

Many indexing problems require greater flexibility than these mechanical devices afforded. Dial indexes have been built with combinations of angular movement through cam-switch operation of a clutch-brake mounted between the drive motor and a gear reduction unit. If precise location is necessary, locating pins are incorporated. Change from a six-station index, 60 deg, to a four-station index, 90 deg, is simply accomplished by rearrangement of the cam switch.

For example, accurate positioning of a 7 ft dia rotary index table, in a special engine head cleaning machine, was obtained by combination of a ¼ hp standard electric motor, a size 500 electric clutch-brake combination, and a stock 100:1 ratio gear reducer. The table was required to index 120 deg in approximately three seconds. The repetitively accurate positioning of the brake at 1,750 rpm was more precise at 17½ rpm, the output speed of the reducer. No mechanical lock was needed to position the work over the flushing nozzles.

Many machine tool and conveyor installations require close synchronization of parallel motions—accomplished through cam switch and electric clutch application. In such applications it is only necessary to adjust

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the cam switch to an approximate location and depend upon the individual clutch voltage resistor adjustment to adjust the synchronization and timing.

Synchronous movement and precise timing were required for a successfully operated wire assembly machine. Two feed rolls were engaged simultaneously by a clutch-brake combination to feed two parallel strands of wire for a predetermined linear length. A fraction of a second after stopping, a cross wire was moved into place and cut to length by another clutch-brake drive — prior to resistance welding at the two points of contact. After a certain number of cross wires were welded to the parallel wires, another clutch-brake was cycled by a timer to cam-operate a vertical shear which cut the entire assembly to length. The resultant product was a ladder-shaped wire assembly, automatically produced at the rate of 300 per hour.

Surface Endurance Limits Of Engineering Materials

Abstracted from "A Progress Report on the Surface Endurance Limits of Engineering Materials," by G. J. Talbourdet, United Shoe Machinery Corporation, Beverly, Mass., ASME Lubrication Conference, October 18-20, 1954, Baltimore, Maryland.

In the design of machine elements such as gears, cams, rollers, a knowledge of the surface endurance limits of the mating materials is of primary importance, because optimum design requires consideration of both the fatigue strength and the resistance to surface fatigue of the machine parts.

Surface failures are similar in many respects. The surface-wear testing machine designed by Prof. Earle Buckingham of M.I.T. for determining the load stress or wear factors of cylinders subjected to rolling and combined rolling and sliding conditions could be used to determine the limiting loads for surface wear on gear teeth, cams and rollers.

The test rolls are mounted on two arbors, which are driven by gears to give either rolling action between the test rolls or a combined rolling and sliding action. One arbor is mounted on a fixed frame, while the other is on a swinging frame. Load is applied by a calibrated spring. For rolling, and combined rolling and up to 30 percent sliding included, the gear ratio is 1 to

1. For combined rolling and from 50 to 75 percent sliding, the gear ratio is 23 to 40, and the speed of the driven test roll is about 598 rpm.

Cast Iron and Steel Roll Tests

Test procedure is to start the machine at no load and gradually increase the load until full load is applied to the rolls. When the rolls are made from a ductile material and also subjected to combined rolling and high sliding conditions, the load must be applied more slowly because of the increase in tangential friction force and the rate of sliding.

The maximum specific compressive stress of the rolls is determined by the Hertz equation. A close agreement exists between the Hertz theory regarding the radii of curvature of the rolls and the modulus of elasticity of the materials. Therefore:

$$S^2 = \frac{0.35W(1/r_1 + 1/r_2)}{1/E_1 + 1/E_2}$$

where: S = maximum specific compressive stress, psi
W = load on rolls, lb per in. of length
r_1 and r_2 = radii of rolls, in.
E_1 and E_2 = modulus of elasticity of roll material

For application in practice, an experimental factor of load and stress concentration based upon test values have been introduced. K_1 equals the experimental load-stress per inch of contact for two cylinders or rolls. Therefore:

$$K_1 = W(1/r_1 + 1/r_2)$$

$$W = \frac{K_1}{1/r_1 + 1/r_2}$$

$$S = \frac{0.35\,K_1}{1/E_1 + 1/E_2}$$

For involute spur-gear teeth

$$K = K_1 \sin \tfrac{1}{2}$$

Knowing the load-stress factor, K_1, for given materials or a combination of materials, and the radius of curvature of the contacting bodies, the limiting load can be calculated. This limiting load is the one which can be carried indefinitely without appreciable wear. If abrasive particles are present, this value does not apply. With ductile materials subjected to rolling action only, no surface breakdown should be expected after about 40 million repeated cycles of stress. With hardened steel materials the number is about 500 million. With combined rolling and sliding condi-

...thermal sensing unit

C·P·I PLUGSTAT®

—wherever temperature limit indication is required

CPI PLUGSTATS provide precise thermal warning without calibration drift. Small physical size has been combined with rugged construction. Special alloy contacts assure clean make-and-break. Capable of 200°F overshoot from high or low normal setting. Available also with AN connector. Rated at ¼ ampere, 28 volts, AC or DC resistive loads. Contacts NO or NC. Weight approx. 1.5 oz.

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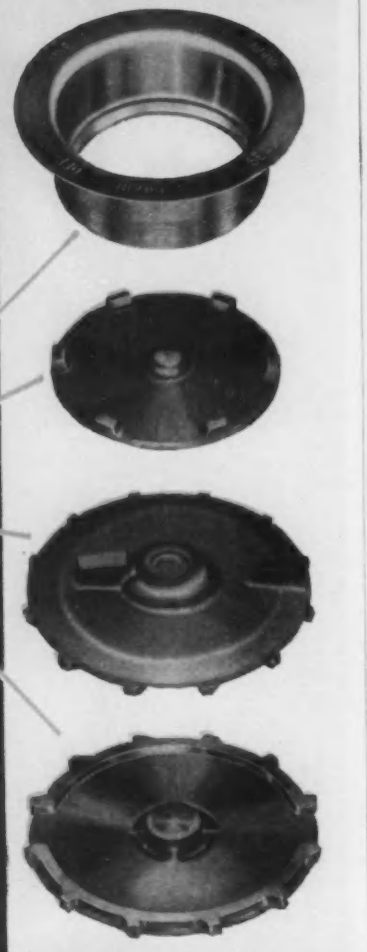
MUELLER BRASS CO. forgings* contribute to the efficiency of this modern waste disposal unit

***MUELLER BRASS CO. facilities include: designing, die-making, forging, tooling, machining, polishing, plating and assembly**



Three Mueller Brass Co. forgings play an important part in the fine operating performance of this modern waste disposal unit made by the Eureka-Williams Co., Division of the Henney Motor Co., Inc. This unit does a speedy and thoroughly effective job of pulverizing garbage and has made life easier for American housewives. The impeller disposer that chops up the waste food in the disposal unit, the disposer cover and the sink mounting flange are all forged by the Mueller Brass Co. This is another outstanding instance where Mueller Brass Co. forgings have improved product performance and cut costs. High quality forgings can be produced from standard and special brass, bronze and aluminum alloys. And in addition, the Mueller Brass Co. offers complete service ranging from product design to finished part . . . Write today for complete information and new 32 page forgings handbook.

1. Sink mounting flange, forged, machined, nickel and chrome plated by Mueller Brass Co.
2. Machined and finished disposer cover forging.
3. Cutting side of impeller disposer forged from 600 series bearing bronze.
4. Reverse side of impeller disposer.

MUELLER BRASS CO.

PORT HURON 17, MICHIGAN

tions the value depends upon the per cent of sliding because of the effects of the tangential friction force upon the shear set up of the material. With non-metallic materials it also depends on the rapidity of the cycle.

Summary of Test Results

The greatest resistance to surface fatigue happens under rolling conditions; when the mating bodies are subject to rolling contact only. With combined rolling and sliding actions, the resistance to surface fatigue is influenced by the sliding action—the greater the per cent sliding the lower the resistance to surface fatigue. The load-stress factors, however, do not decrease proportionately with the increase in per cent sliding. Their value depends on the materials and on the combination of materials of the mating rolls, which affect the tangential friction load between the contacting surfaces—hence, the shear stresses on and below the surface layer. Lubrication is also more important than under pure rolling contact.

Fatigue cracking of rolls subjected to pure rolling contact indicate cracking below the surface layer and in the region where the shear stress is a maximum. It appears that under repeated cycles of stress, the cracks grow progressively and up to the surface layer. When particles break out, destructive pitting occurs. Combined rolling and sliding action may result in cracking nearer the surface and perhaps on it. This is probably caused by the tangential friction load caused by the sliding action.

The surface finish of materials having some degree of plasticity is improved to an appreciable amount by the repeated cycles of stress, the load, and the per cent sliding. The surface endurance limits or limiting load-stress factors of cast-iron materials depend not only on the hardness but also on the microstructure. Close-grain structure with a fine graphite dispersion appear to give optimum resistance to surface fatigue.

The load-stress factors for low-carbon steel rolls are not as favorable as those for close-grain cast-iron rolls and they are only a fraction of the load-stress factors for medium-carbon heat-treated rolls. These finds are of importance in the choice of materials for gears and cams.

OUR READERS SAY . . . . . .

Letters should be addressed to The Editor, *Product Engineering*, 330 West 42nd St., New York 36, N. Y.

How Simplified Should Simplified Drafting Be?

To the Editor:

The article "Should Current Drafting Practices be Further Simplified," by Dean Gerardi, of the University of Detroit, as published in the May 1954 issue of *Product Engineering* was a revelation in the respect of what has been done to standardize and/or simplify drafting practices.

Through our experience operating as a job shop and having subcontracted work for all the major aircraft companies, further simplification would only lead to more confusion without rigid standardization.

It has been our practice to hire, if possible, the best qualified employees in order that we can compete with the prime contractors' design and fabrication departments. Without first-class help, we would be unable to design and fabricate aircraft tooling cheaper and faster than the prime contractors themselves. These employees have all had a large portion of their experience with the prime contractors or larger companies, and their ability to read and interpret engineering drawings excels only when these drawings come from the firms with whom they have had the majority of their experience. The transition period required by the new employee or by the employee who has not had experience with the prime contractors' engineering drawings often results in considerable expense on our part or in revised schedule dates on the part of the prime contractor.

The present drafting practices now used and viewed as an overall picture are very concise and enable the average shop tradesman or designer to quickly ascertain what is required. However, when we look further into the picture at specific details and compare one company's engineering drawings with another, we find that an extensive standardization program

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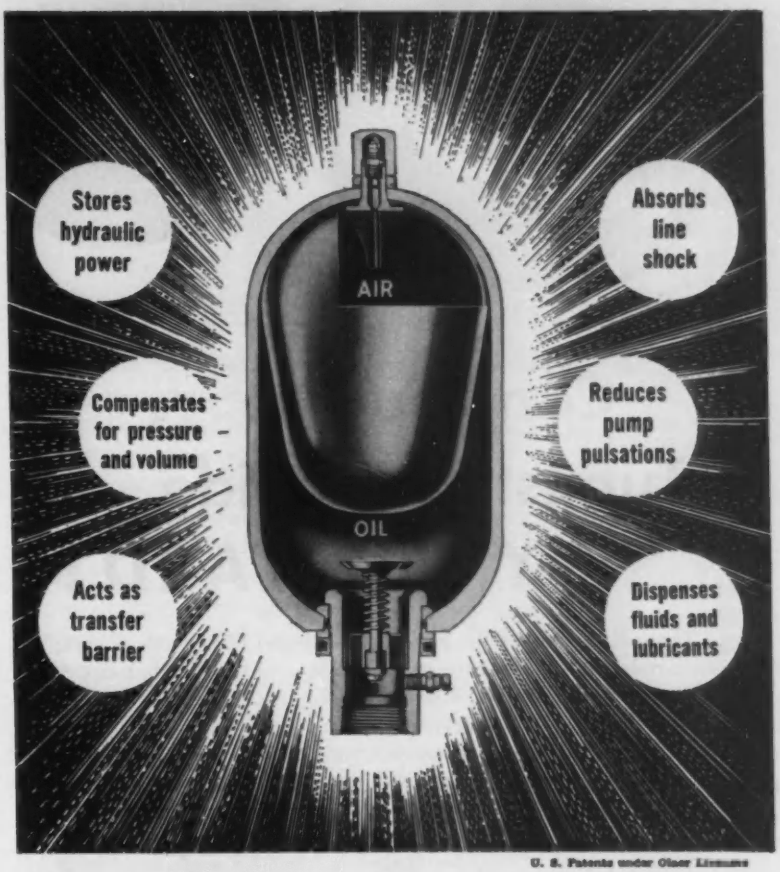

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Can You Use . . . Tungsten Carbide BY THE YARD?

These thin steel strips have been Flame-Plated with a hard, wear-resistant coating of tungsten carbide—yet they can be twisted, curled, bent, and flexed without cracking or chipping the carbide coating. Strips of any length made of most any metal can now be Flame-Plated to provide long-wearing surfaces. Where can these strips be used? We don't know, but if you have a probable application, we'd like to talk to you about it.

Flame-Plating is a new LINDE process for applying wear-resistant coatings of tungsten carbide to the wear surfaces of parts and many tools made of most common metals. For the full story on Flame-Plating, read the new "Flame-Plating" booklet.

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would probably do more in a national emergency than did the United States and British Government's decision to standardize on a thread form.

I heartily agree that the need for national standardization is evident. However, I would vote a resounding "No!" to the question of further simplification.

Thank you for a very interesting article which provided much food for thought and conversation.

—OLIVER A. BRADLEY
L M Engineering Co.

Ed—Author Gerardi replies:

I am grateful for your comments and particularly pleased that you note the work which is in progress regarding drafting standards. While neither of us would minimize the great amount of good which resulted from unified thread forms, I share your opinion that drafting standards would contribute much more in another national emergency, as well as in the manufacture of civilian products.

You would be interested to know that a joint committee of aeronautical and automotive engineers met recently in New York City. It is quite probable that complete reconciliation will soon be reached on all those matters in which a difference of opinion has existed. Of course, these proposed standards must then be submitted to industry for comment and approved by the Technical Board of the Society of Automotive Engineers.

Smoothing Out A Casting Problem

To the Editor:

We are having trouble obtaining shell mold castings of the desired surface smoothness for use on research instruments. Our Buffalo vendor has trouble maintaining proper surface quality. Could you suggest a firm or firms equipped to supply short runs of shell molded *aluminum* castings of surface quality suitable for quality instruments? H.E.P.

Ed—The difficulty you are having may be due to the nature of the shell mold. The high porosity of the mold results in a rougher casting with aluminum than normally is obtained with other metals, particularly the ferrous metals. The molten aluminum

tends to fill the pores of the shell, resulting in a somewhat rough casting. To partially compensate for this, different resin-sand mixes are used for shell molds when casting aluminum.

Quite probably plaster casting would be more suitable for obtaining the smoothness of finish you require. I suggest you investigate this process and refer you to the Buffalo office of the Aluminum Company of America for details. I also refer you to an article on page 164 of *Product Engineering* for September, 1954—"Plaster Casting the Light Metals."

Comment on Print Lettering

To the Editor:

The letter by Mr. Conklin, of *Canadian Machinery*, in the October issue of *Product Engineering* strikes a familiar chord with me. I was taught to print the Charles W. Reinhardt alphabet, using both lower and upper case symbols. This was more than forty years ago.

In about 1916 there was an influx of architects into the realm of mechanical designing. These men were forced from the field of their training by a general lack of building construction. Being adept in the use of a modified type of Roman lettering, known as Gothic, they continued to use it in their new field of endeavor. They claimed that there was less chance of mistakes with the use of Gothic or as it is now known, block lettering.

We mechanical and marine men continued to use lower case lettering, but by 1929 discovered that we would have to change to block lettering if we were to hold our jobs. Actually, I am now considerably more adept in the use of block lettering than in the printing of lower case letters.

I still think, however, that a drafting student can achieve the ability to make clean and unmistakeable legends on drawings with less training if he uses the Reinhardt alphabet. In addition, this alphabet, with the use of lower case letters, is faster to print and slightly easier to read. Perhaps the persistence of block lettering was due to the large number of Slavic workmen who came into industry at the end of World War I and who at that time were only semi-literate.

The use of block lettering on a

...How about Malleable?

Versatile Castability Permits Wide Freedom of Design

The ability of malleable iron to be cast into intricate shapes and close to final form provides the design engineer with an extremely useful ferrous material. Complicated and expensive assemblies can often be combined into one easily machined, tough casting. Drilling and boring operations are often eliminated for further savings.

Whether you are designing new products or reviewing present production keep malleable in mind. Call a malleable foundry and go over your products with their engineers. They can give you information and suggestions that help you design better products that can be made at lower cost.

Free Design and Application Data to Help You Design with Malleable

This issue of Malleable Iron Facts contains valuable data on grades, design and application of malleable iron to aid the design engineer.

Ask your malleable castings supplier for copies or write to the Malleable Founders' Society

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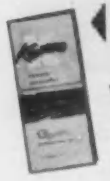

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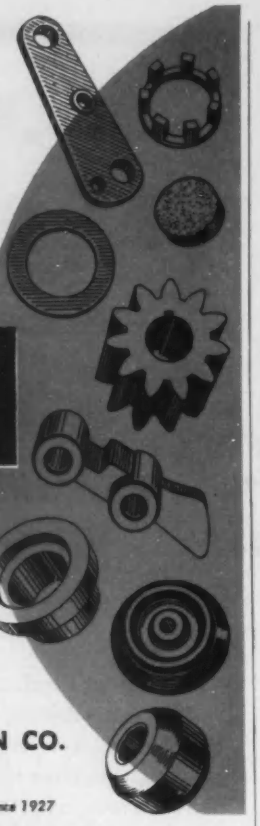

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Write for bulletin 101

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drawing, is to my eye, barbaric in appearance, and its almost universal use today seems a distinct step backward.

—Alan Osbourne
Cabin John, Md.

Another Merger

To the Editor:

Since giving you the initial information on our electronic comparator which you used as a basis for the article "Varying Capacitances Give Gage High Sensitivity" in your September 1954 issue starting on page 152, our company has become a division of Industrial Gages Corporation. Our plant has moved from New York to Englewood, New Jersey, and readers wishing further information should send their inquiries to our new address.

—Richard J. Levi
Electro-Autosizing Machine Div.

A Word to Your Wife Is Sufficient

To the Editor:

My husband is furious over an inexcusable thing I did the other day. To make amends, I am writing to you for help.

As a member of the Drafting Department at Vickers, my husband looks through all his copies of *Product Engineering* and cuts out the pages that are helpful to him in his work. He had put the old copies in the basement along with two copies of the "Annual Handbook of Product Design," and I gave them away to The Salvation Army. Now he is in desperate need for them. I am writing this to see if you can mail the latest Handbook which would probably be the 1954 edition.

He has been a steady subscriber for at least 5 years and enjoys the magazine very much.

So to keep peace in this family, I would appreciate your help.

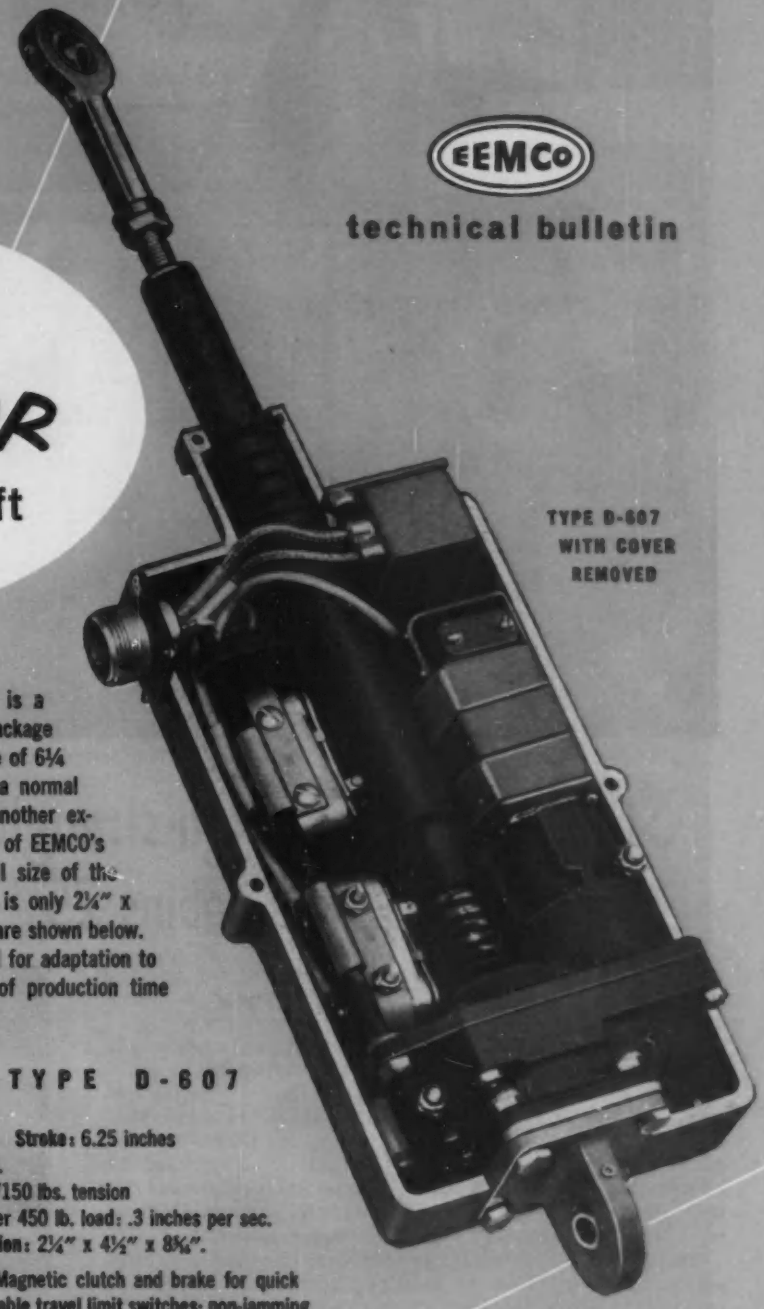
—Mrs. C. Harrow
Detroit 35, Mich.

Ed—We are very sorry to learn of your predicament, but at the same time we are highly pleased to learn your husband finds *Product Engineering* so indispensable. A complimentary copy of the 1954 "Annual Handbook of Product Design" is already on its way to you.

EEMCO

technical bulletin

a New DOOR ACTUATOR for Transport Aircraft



TYPE D-607 WITH COVER REMOVED

EEMCO's new linear actuator, Model D-607 is a compact combination actuator and power package weighing only 4½ pounds. Having a stroke of 6¼ inches at .3 inches per second under a normal operating load of 450 pounds, it is another example of the ingenuity and precision of EEMCO's design and production team. Overall size of the activating section of Model D-607 is only 2¼" x 4½" x 8¾". Other specifications are shown below. This same design can be altered for adaptation to other uses with a minimum of production time thus assuring early delivery.

SPECIFICATIONS ★ TYPE D-607

Weight: 4.5 pounds **Stroke:** 6.25 inches
Operating load: 450 lbs.
Ultimate static load: 7150 lbs. tension
Speed of stroke under 450 lb. load: .3 inches per sec.
Size of power section: 2¼" x 4½" x 8¾".

Other features: Magnetic clutch and brake for quick stopping; adjustable travel limit switches; non-jamming end stops; radio noise filter; explosion proof.

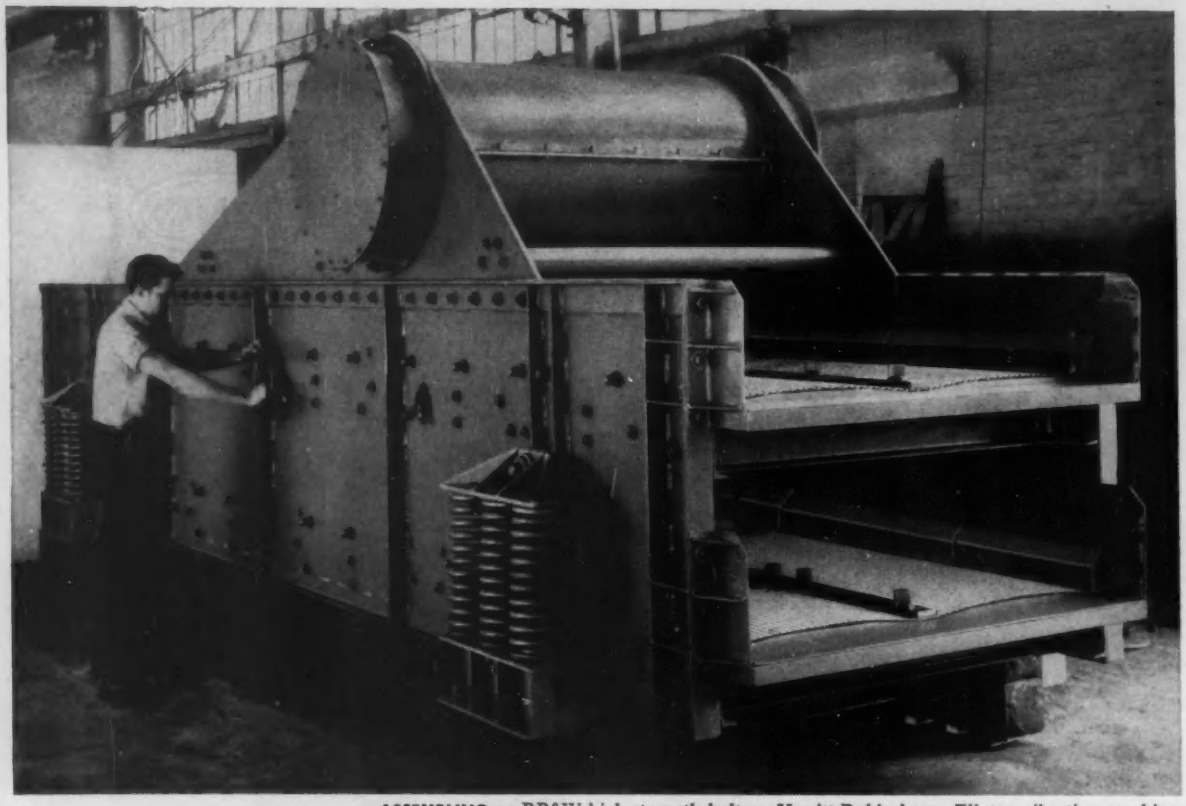
NOTE COMPACTNESS OF COMPLETE UNIT

Electrical Engineering and Manufacturing Corp.

4612 West Jefferson Boulevard
Los Angeles 16, California

Designers and producers of motors, linear and rotary actuators

3-607



ASSEMBLING an RB&W high-strength bolt on Hewitt-Robins' new Eliptex vibrating machine.

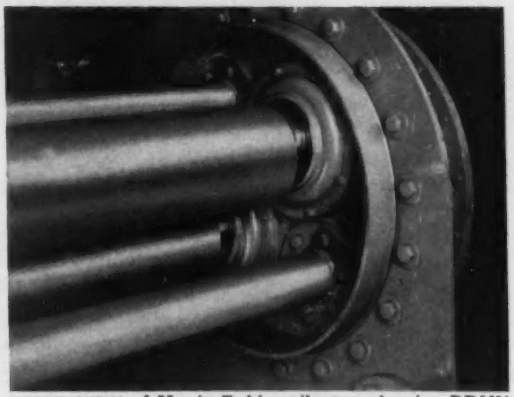
Standardizing on high-strength bolts saves Hewitt-Robins 25%—improves product!

Take a hard look at your fastening operations and you may find you will save a lot by using standard high-strength bolts instead of expensive specials.

Using a standard RB&W high-strength bolt plus a heavy semi-finished nut with two hardened washers, Hewitt-Robins is getting these advantages and savings on vibrating machines: 1. Saving 25% in yearly fastener cost. 2. Eliminating situations requiring body-bound connections with attendant reaming operations. 3. Eliminating all special, finished bolts with varied thread lengths and also all special lock nuts. 4. Eliminating procurement problems and slow delivery of specials. 5. Reducing nut and bolt inventory. 6. Obtaining better performance and lower maintenance on units.

The RB&W product has 2½ to 3 times the clamping force of the previous fasteners. Thus the assembled connection is better able to withstand severe vibration.

Maybe your operation doesn't give fasteners as hard a time as vibrating equipment, but it pays to look into the savings you can expect from specifying standards instead of specials. RB&W has the answers to your questions.



DETAIL VIEW of Hewitt-Robins vibrator, showing RB&W high-strength bolts which must resist shear stress as well as vibration. 4.8

See our insert on high-strength bolts in Sweet's Architectural and Industrial Construction Files.

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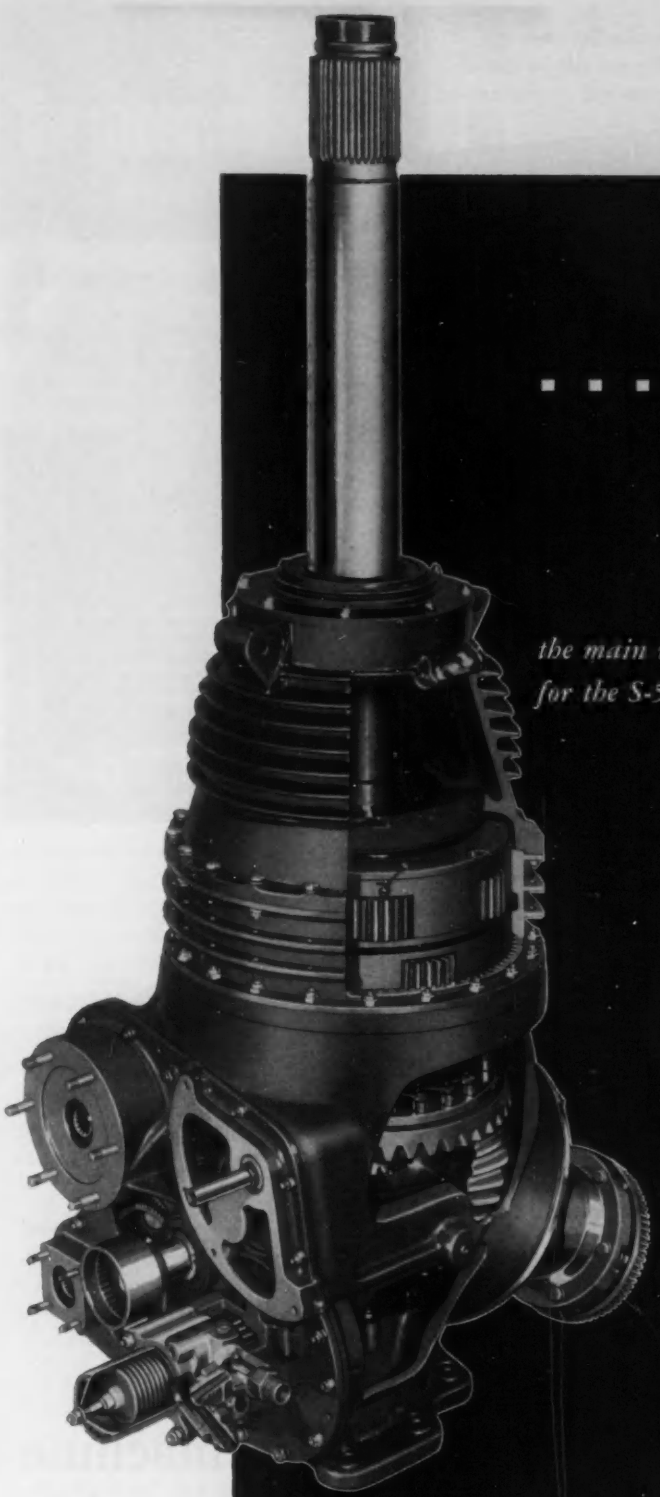

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the main rotor transmission for the S-55 Sikorsky Helicopter.

High on the list of "things we are proud of" at IGW is the transmission shown here (demonstration cut-a-way). Precision built to transmit 700 H. P. with an input speed of 2400 RPM and a reduction ratio of 11.348 to 1. In spite of high stresses and great complesity the service life of this transmission has been outstanding.

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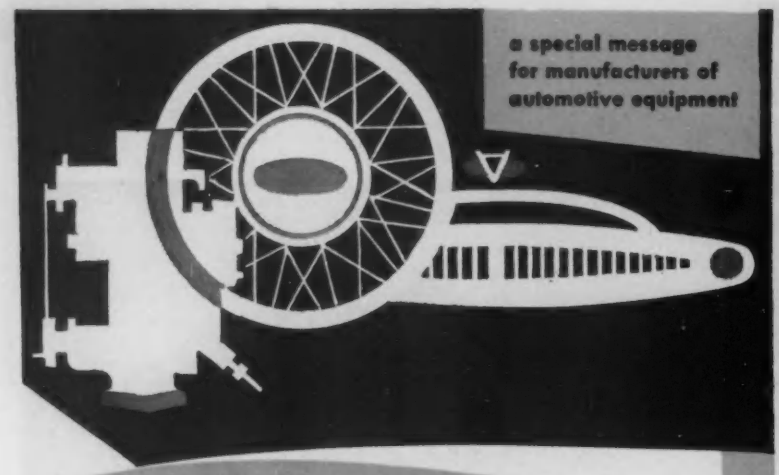

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Argon gas being used as a backing agent replacing backing rings . . . Welding operations are fast and simple.

ELIMINATE Backing Rings

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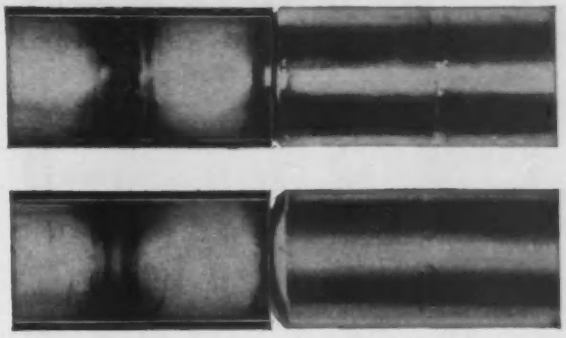
The combination of stainless steel pipe and HELIARC welding with argon gas backing produces a corrosion-resistant piping system—ideal for handling foods, fluid metals, corrosive liquids, high-pressure and high-temperature steam, and pharmaceutical products.

No backing rings—argon replaces the atmosphere in the section of pipe to be welded, and protects the weld bead from the underside as it is formed. This eliminates the need for metal backing rings.

New torch techniques allow the operator to control the size and shape of the penetration bead inside the pipe, while he is making the weld.

Smooth, sound joints—every time. HELIARC welding produces joints free from obstructions, notches, and crevices which hinder or trap flowing materials within the piping system. The penetration bead in the pipe is held within 1/32-in. of the pipe's normal inside diameter.

For the full story on argon-backed, stainless steel pipe fabrication, ask your local LINDE representative for the booklet, "Inert-Tungsten Arc Welding of Stainless Steel Piping," F-8463. In addition, he will be glad to give you complete information on how HELIARC welding cuts time and cost in many other applications. Start saving now—call him today.



Top—interior and exterior of completed welds without argon backing. Bottom—with argon backing, note the smooth, porosity-free, high quality welds.

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A Division of Union Carbide and Carbon Corporation

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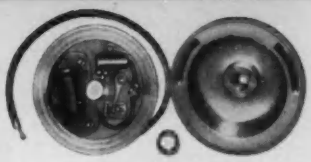

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Molded heavy-duty high tension coil, large, long-lasting breaker points and Alnico permanent magnets are just a few of the features that assure easy starting and peak performance for your engine. Call on us for engineering help. The benefits of our experience gained in building over 3½ million magnetos along with our research and testing facilities are yours upon request.

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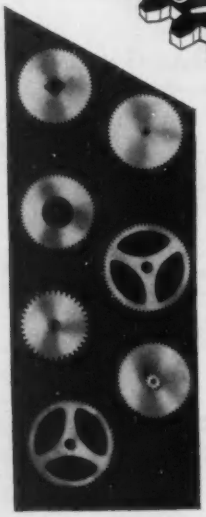

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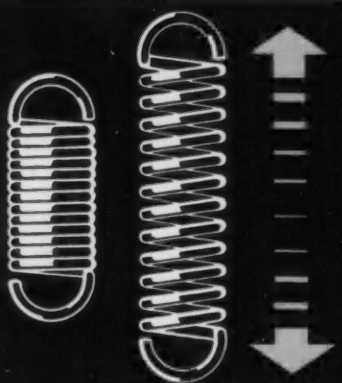

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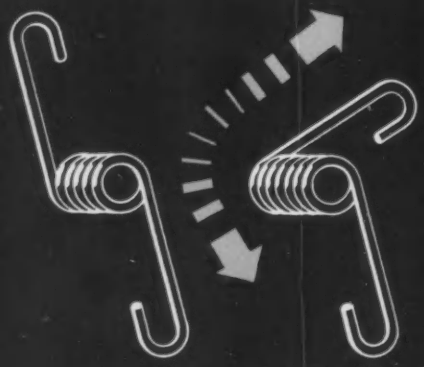
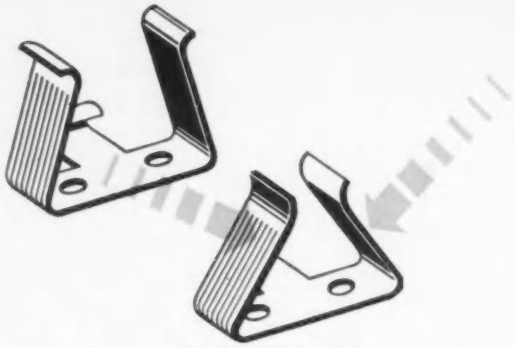


TORSION SPRINGS



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- ***a process* that accurately generates cylindrical and flat surfaces at minimum cost . . .***
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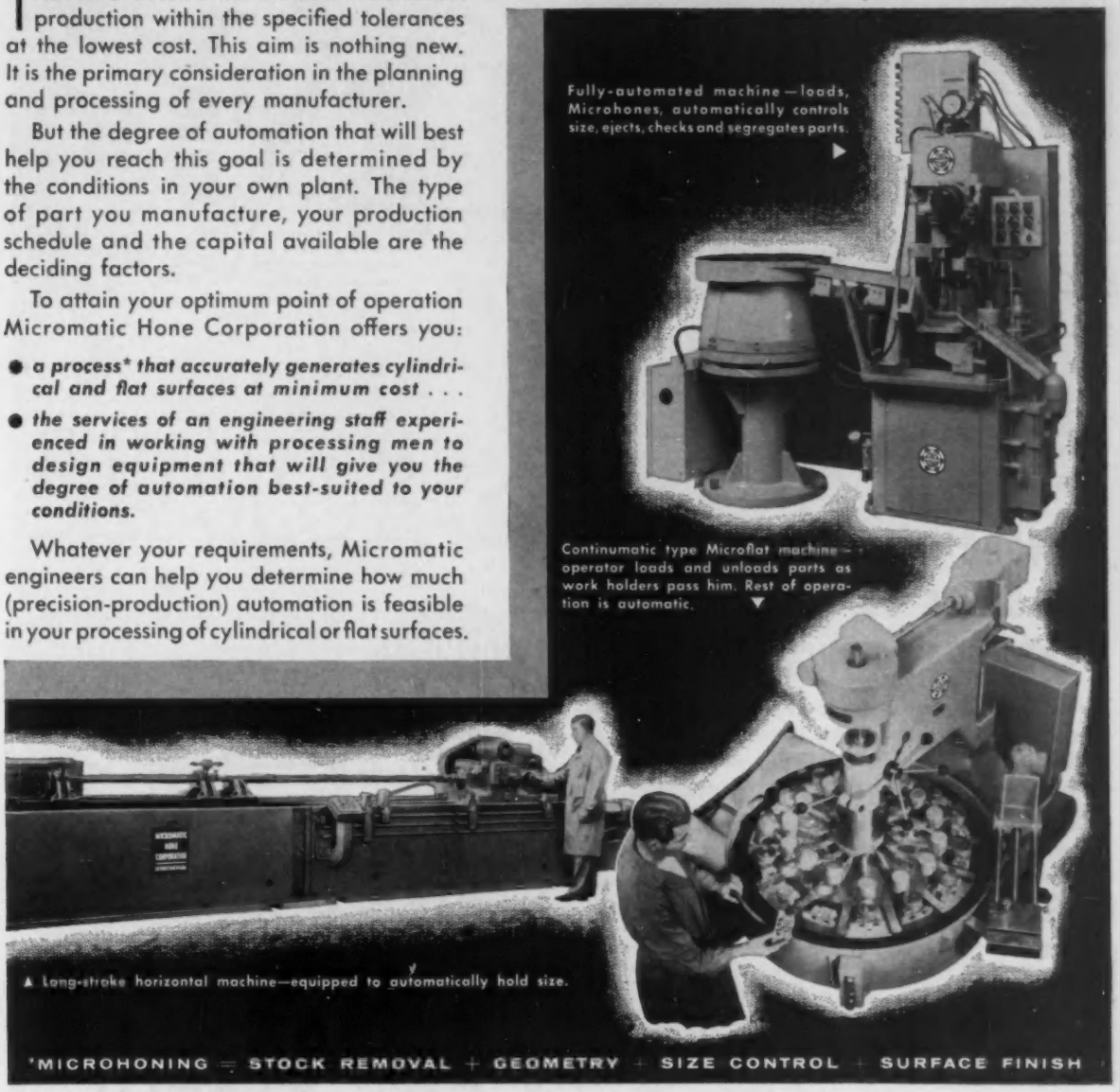
Whatever your requirements, Micromatic engineers can help you determine how much (precision-production) automation is feasible in your processing of cylindrical or flat surfaces.



Fully-automated machine—loads, Microhones, automatically controls size, ejects, checks and segregates parts. ▶

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QUALITY CONTROL: Chemical and physical affidavits furnished. Test Bars submitted. Produced with 100% X-Ray requirements.

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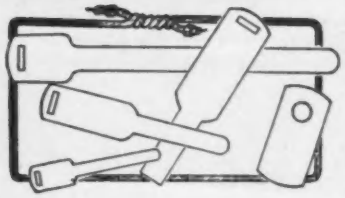

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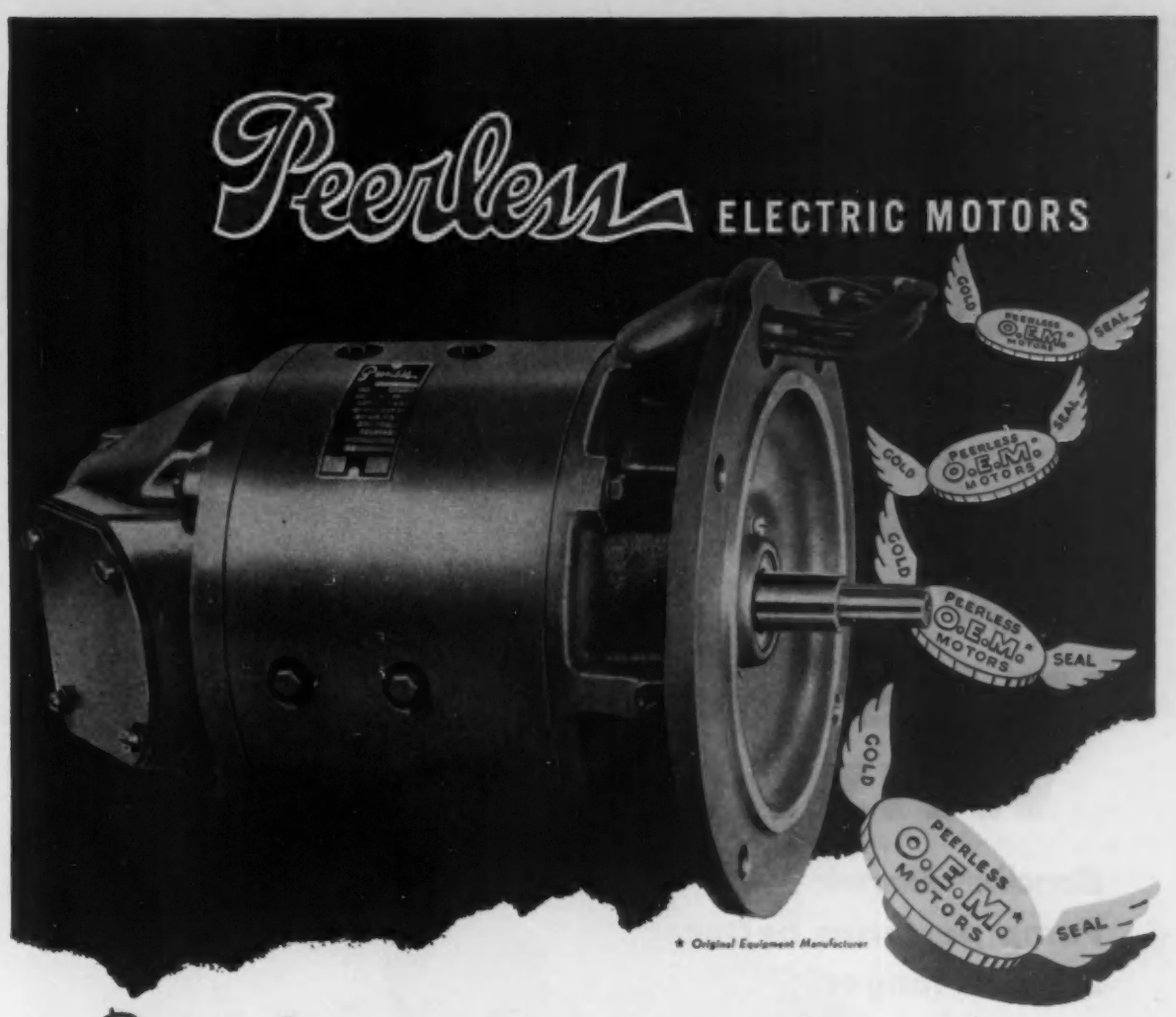

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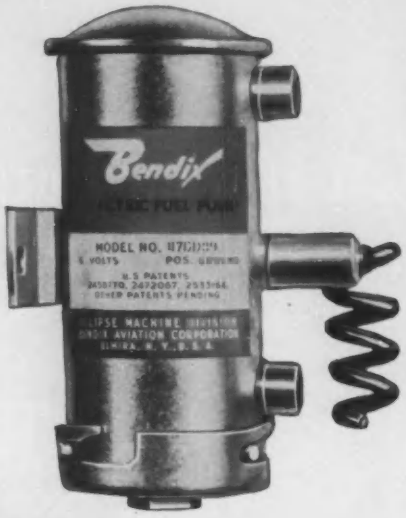

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this graphitized plastic bearing

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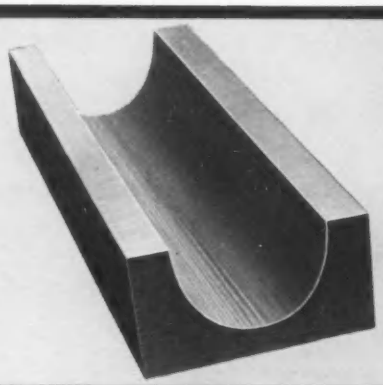
WITHOUT LUBRICATION



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is ideal where lubrication is difficult. Eliminates oil or grease contamination.

Here is a graphitized plastic laminate that is excellent for many bearing applications where speed, load, and frictional heat are low. In such cases no lubrication may be required. In other applications of heavy load and high speed, where frictional heat will develop, this bearing can be lubricated and cooled with water or other non-corrosive fluids, thus avoiding the danger of staining or contamination from oil or grease.

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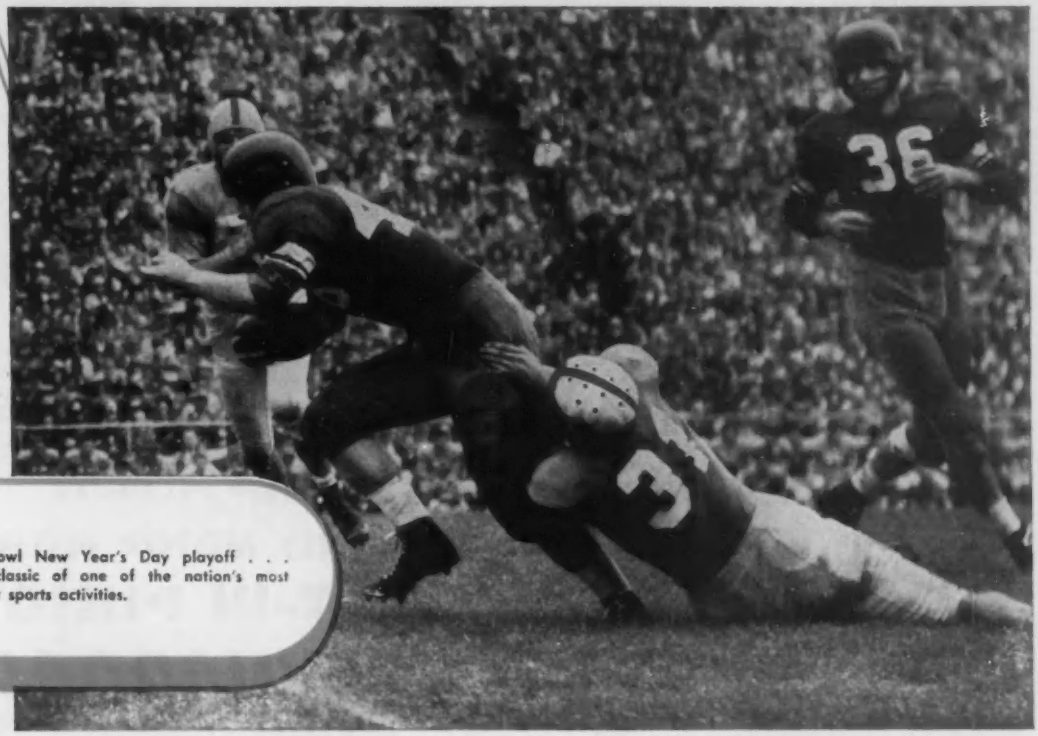

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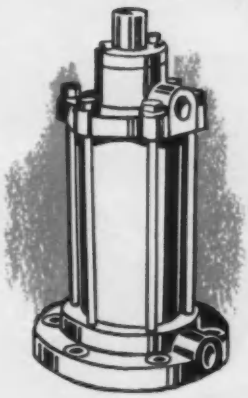

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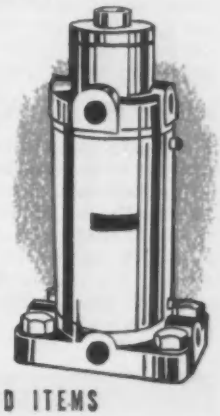

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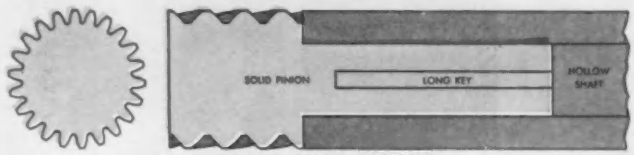
In your opinion, which pinion?

. . . for longest life in a gearmotor

ORDINARY SHELL TYPE PINION



U. S. SOLID TYPE PINION

In an internally geared motor the pinion on the motor shaft is the vital link between motor and gearing. It's the fastest, but smallest gear, so it must be extra strong, free from vibration and forever tight. Now compare the U. S. Syncrogear motor pinion with the ordinary type. Note the extra large section area of the U. S. design. It has a long solid shank that anchors into the motor's hollow shaft, whereas the ordinary shell type has a small section area, short keyed.

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BUILT-IN PINION

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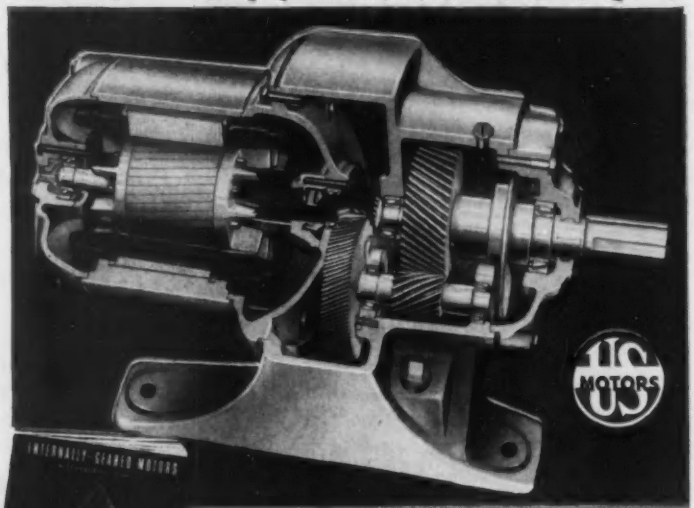

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MC-185	"High Impact," Lowest Water Absorption Rate
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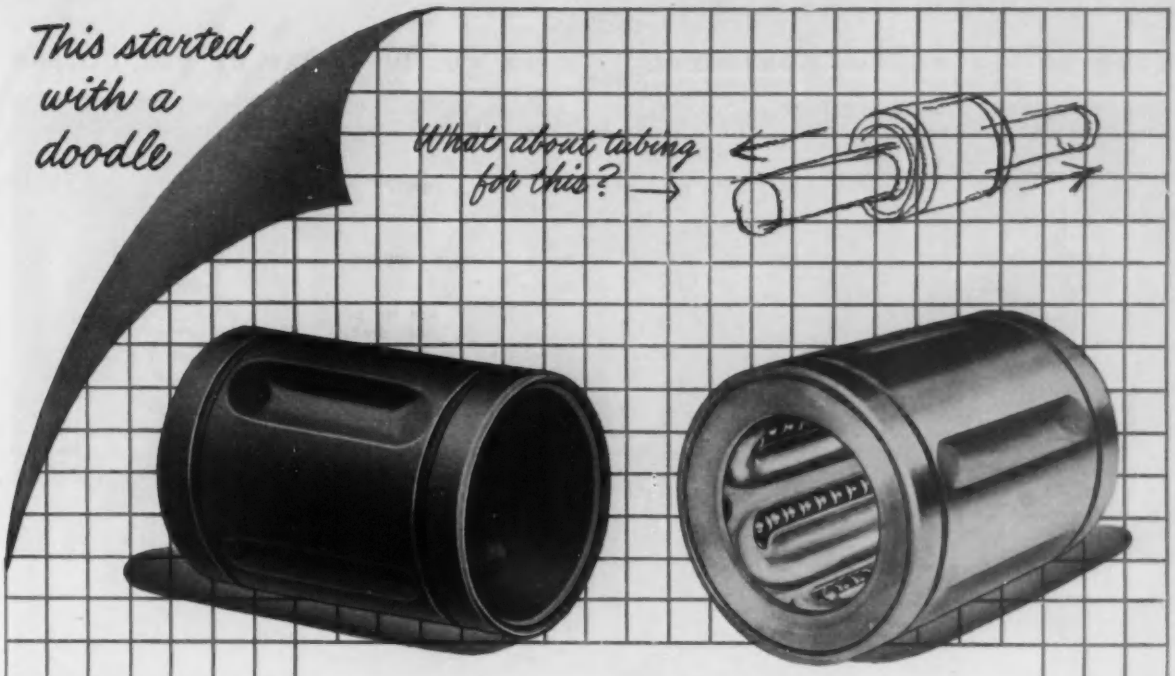
This started with a doodle

What about tubing for this? →



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Tubing tolerance is a big "must" on this job. Thomson Industries, Manhasset, N.Y., insists on it. Otherwise, manufacturing BALL BUSHINGS (ball bearings for linear motion) would have been even tougher than it was.

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The tubing that has all these advantages is Republic ELECTRUNITE, a *precision* mechanical tubing for applications like this. You can get it in carbon or stainless analyses. And Republic engineers will be glad to help you use it, profitably, in whatever products you make. Call your nearest Republic Sales Office or write to:

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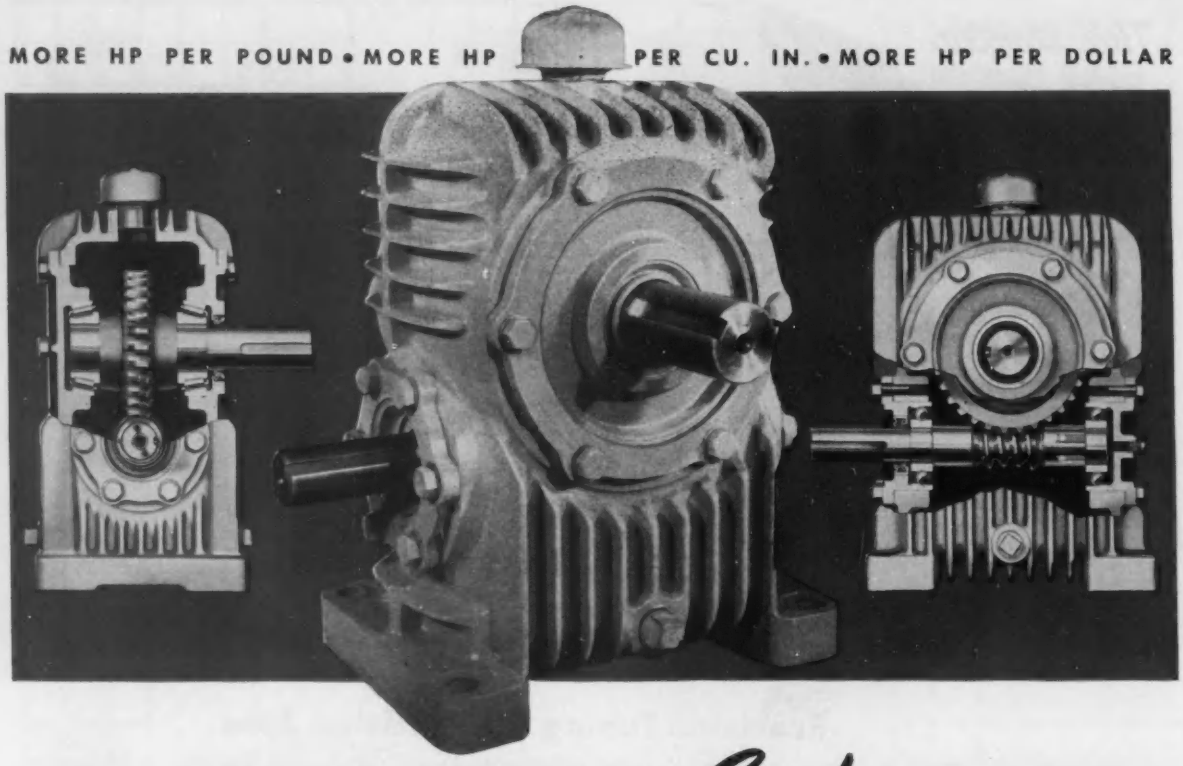

190,000 STANDARD *Stock* ANSWERS TO *Your* DRIVE PROBLEMS

Look closely at the cutaway views above. Note how the worm wraps around the gear and the gear around the worm. That's the double-enveloping principle of Cone-Drive gears. It gives you high load-carrying capacity, long life and less weight, all in an extremely compact unit.

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Yet, you can select any one of 190,000 standard stock reducers to solve your specific drive problem the efficient way.

You can choose ratios from 5:1 to 4900:1.

You can handle loads from fractional to 800 hp.

You get all this with only 58 standardized mountings.

Cone-Drive gears offers this versatility because of their modern manufacturing methods. All parts for a given center distance—gears, mountings, bearings, housings, fan-cooling attachments and water cooling coils, etc.—are standardized whether you require worm under or over, gear shaft vertical or horizontal, single or double-extended shafts, right or left hand. All of these parts are completely interchangeable for a given center distance, too.

Find out more about Cone-Drive speed reducers. Ask for Bulletin 8901-50.

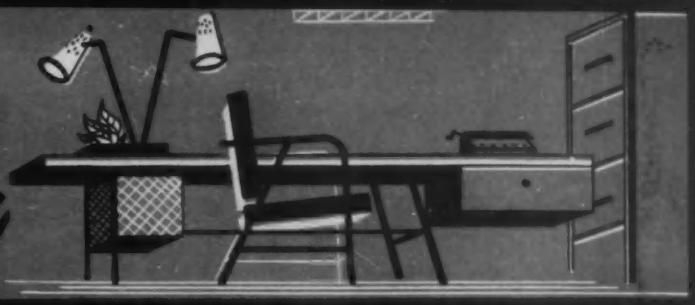
CONE-DRIVE GEARS

Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

looking for metal furniture ideas?



Could be you are overlooking a good bet if you aren't familiar with what Van Huffel can do in cold forming metal shapes and tubing.

To give you a better picture of how other manufacturers are cutting costs and improving their products, we have prepared a portfolio of ideas that should be in your file. It's yours free for the asking.

FREE FOR YOUR FILES

VAN HUFFEL TUBE CORPORATION
WARREN, OHIO

Please send me the METAL FURNITURE idea portolio MF-312

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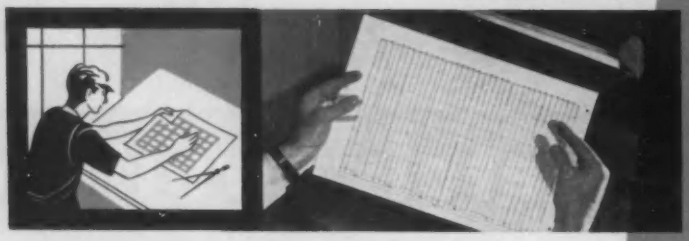

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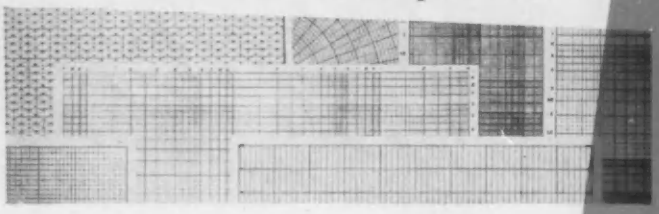

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and other popular rulings—Standard sheets—8½" x 11" and 11" x 17"

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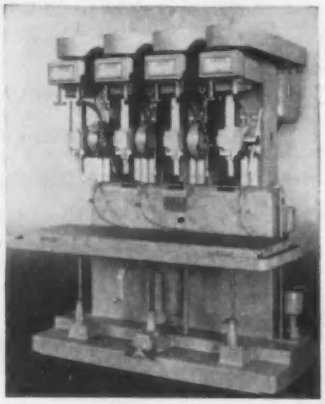

Ruthman GUSHER coolant pumps

Illustrated is a Leland-Gifford No. 3-MVB Four Spindle Drilling Machine equipped with a Ruthman Pump.

Based on performance Gusher Coolant Pumps are economical in initial price . . . economical in operation. They give split second coolant flow—use less power when throttled—require a minimum of maintenance. Pre-lubricated heavy-duty ball-bearings and an electronically balanced rotating shaft assembly guarantees long trouble-free life for your Gusher Pump. *Write for catalog today.*

THE RUTHMAN MACHINERY CO.

1818 Reading Road — Cincinnati, Ohio

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● Standard or special rubber insulated clips, clamps and fasteners for cable, loom, tube, wire, rod and pipe . . . rubber or neoprene applied in desired thickness for complete or partial coverage to metal stampings of any size or shape . . . ARco form dipped rubber parts, quickly, economically produced . . . these ARco products and services are helping development engineers solve problems and simplify purchasing for manufactures. Consult ARco engineers today.

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NAME YOUR NEED

COATED FIBROUS MATERIALS MAY BE BEST ANSWER

Like to take advantage of the economies of fiber boards, but feel they are too limited electrically or physically for your needs? Take a look at our coated DUROIDS.

You'd have to go to laminates to get a lower rate of moisture pick-up. Flexural strength is greatly improved. Appearance-wise, coated DUROIDS are slick, smooth and shiny.

One user, interested in improved arc resistance for a low voltage application, tested DUROID 800 with an epoxy coating. Result: our material showed no sign of failure after a test period 2000 cycles longer than the point at which the next best material (fiber board on laminated phenolic) had broken down.

We are equipped to coat our DUROIDS to your specific requirements, using a wide range of surfaces, including epoxies, vinyls, alkyds, etc. Name your need — coated DUROIDS may be the best and lowest cost solution.

Write Dept. E for engineering data and appearance samples

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ROGERS, CONNECTICUT

PRODUCTS

DUROIDS — for Gaskets, Filters, Electronic Devices, etc.
ELECTRICAL INSULATION — for Motors, Transformers, Generators, etc.
SHOE MATERIALS — for Counters, Midsoles, Liners, etc.
PLASTICS — Special Purpose Molding Compounds and Laminates

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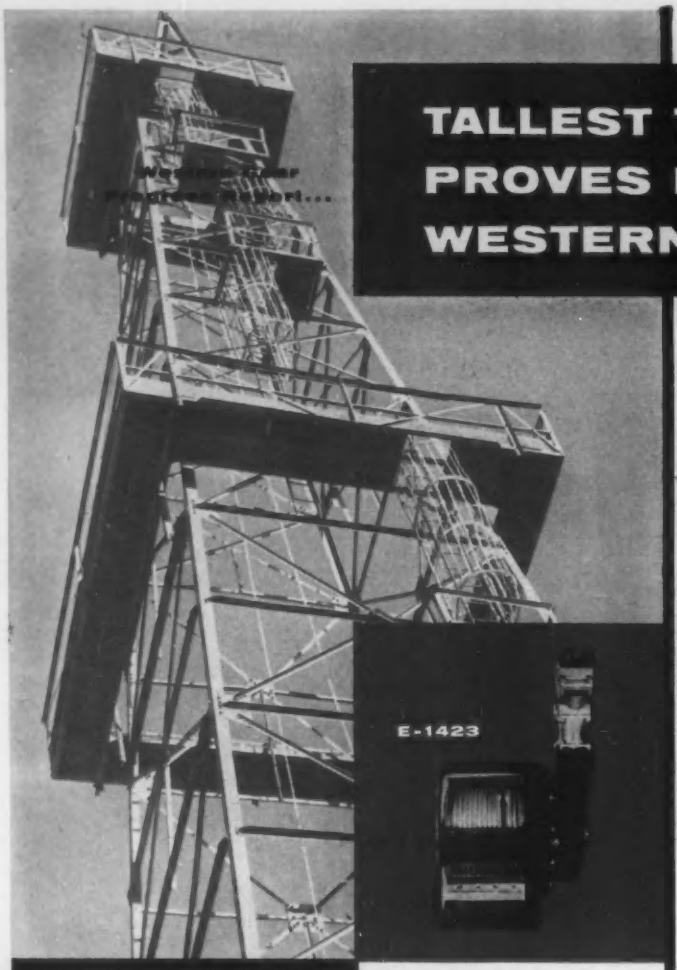
Better Parts for Better Products

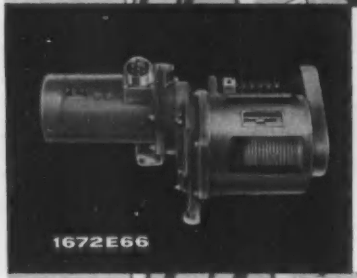


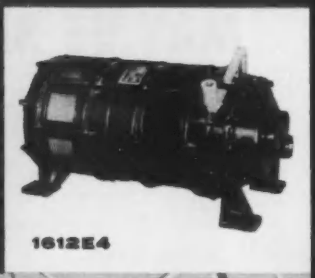
TALLEST TEST STAND PROVES RELIABILITY OF WESTERN GEAR HOISTS

One of the world's tallest hoist test stands, this 120' tower erected at the Lynwood plant of Western Gear Works provides exact duplication of the dynamic conditions experienced on a cable at full length and on hoist mechanisms when raising and lowering specified loads. It also enables Western Gear engineers to study the regenerative motor characteristics involved during lowering. Data thus obtained provides positive information on cable up to 120' in length, motive power and hoist mechanism itself.

It's another example of Western Gear thoroughness which characterizes all its products.

Western Gear has been designing and building hoists and other specialized equipment for transmitting motion or torque for virtually every industrial application. Why not take advantage of this experience and skill in solving your mechanical power transmission problems? No obligation! Address inquiries to Executive Offices, Western Gear Works, P.O. Box 182, Lynwood, California.

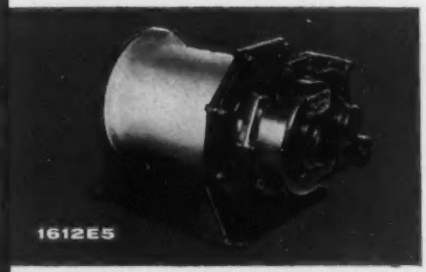




MODEL E-1423 CABLE DRUM: Spooling capacity, 20' of ¼" cable. Maximum cable pull 6500 lbs. Unlimited travel. Speed 8 RPM. Powered by hydraulic motor. Direction, reversible.

MODEL 1612E4 HOIST: Has 50' of active cable drum capacity. 55' of 3/16" diameter cable. Operating load up to 1600 lbs. Capable of operating 30 FPM. Incorporates unique feature of paying cable off at a fixed point. Powered by a low pressure air motor with hand crank for emergency operation.

MODEL 1672E66 HOIST: Spools 150' of 3/16" cable; 800 lbs. operating load. 50 FPM average cable speed. Maximum lift of 1200 lbs. Ultimate static load 3,000 lbs. Cable level wind device furnished. Unit powered by 28 V. DC motor.



MODEL 1612E5 CAPSTAN: For use with rope. Has operating load of 1600 lbs. at rate of 30 feet per minute. Powered by low pressure air motor.

WESTERN GEAR WORKS

Since 1888

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

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PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

"We've been in the dark"

"Miss Jones—

"These notes cover what I intend to discuss at the committee meeting tomorrow. Please type them and attach them to the Wolverine proposal we received this morning. And set up my office for a 10:00 meeting tomorrow."

• • •

"Gentlemen:

"As you know we've been in the dark for some time as to how best increase the capacity of our heat exchangers. Space is at a premium, and the obvious answer of a larger heat exchange unit is out of the question.

"I've been talking to some of the men at Wolverine Tube and they've come up with what looks like the answer. They suggest using Wolverine Trufin*—their integral finned tube. Wolverine extrudes the fins right from the tube wall: Trufin is just about the most efficient tube I've ever seen. We can boost our output, improve our product at the same time.

"There are other advantages, too. Trufin can be bent or coiled just as easily as plain tube. In order to meet varying corrosive conditions, it's made in several metals: copper and copper-base alloys, aluminum, electric-welded and stainless steel, bi-metal and others.

"I've prepared some rough figures to show just what cost advantages we can expect from Wolverine. They've given me a quotation, too, which I'd like to go over with you." Wolverine Tube, 1479 Central Avenue, Detroit 9, Michigan.

WOLVERINE TUBE
DIVISION OF CALUMET & HECLA, INC.

Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

*REGISTERED U. S. PATENT OFFICE

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ont.

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

EXPORT DEPARTMENT, 11 EAST 40TH STREET, NEW YORK 16, N. Y.

FRONT VIEW

SIDE VIEW

Hartwell Flush Latches

AVAILABLE FOR OVER

300 COMBINATIONS OF DOOR AND FRAME THICKNESSES

HARTWELL Trigger-action Flush Latches are produced in over 300 standard combinations of bolt and trigger offsets. We can supply a latch for any door to be latched in any frame within thickness ranges common to standard sheet metal practice.

No altering of panels and frames is necessary when HARTWELL Flush Latches are installed. Offsets of bolt and trigger are stamped on each part for rapid and accurate selection of the correct latch for each installation.

All HARTWELL Flush Latches and Hinges are the result of nearly two decades of continuous specialized design and manufacture.

New 1954 Catalog illustrates and gives full details of complete line.

MAIL THIS COUPON

HARTWELL COMPANY
9035 Venice Blvd., Los Angeles 34, Calif.
Send Illustrated 1954 Catalog.

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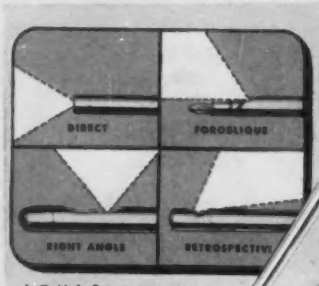
A.C.M.I. BORESCOPES

for close-up visual inspection of internal surfaces and hidden parts



A. C. M. I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00" —in lengths of 4" to 720". Special models for special problems.

A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling. • Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

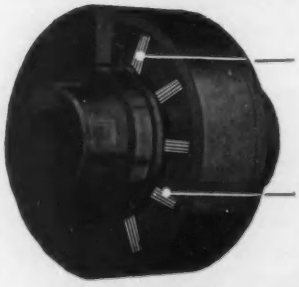
Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

HERE'S WHY

KUSHION-TORQ

LENGTHENS EQUIPMENT LIFE



Laminated Kantilever Steel Springs transmit driving action.

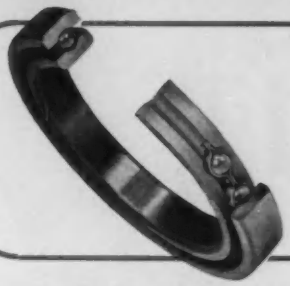
Tapered slots move point of driving contact inward as loads increase to automatically stiffen kantilevers.

These Brown Coupling features mean equipment is shock and load protected - - - coupling failure is reduced - - - misalignment is corrected - - - radial and torsional vibration are dampened - - - both drive and driven units last longer.

For complete information shown in Bulletin 28P, write Brown Engineering Co., 108 N. 3rd St., Reading, Pa.

BROWN KUSHION-TORQ **COUPLINGS**

BCA ENGINEERING COOPERATION AND DESIGN ASSISTANCE Bring You The Advantages Of Ball Bearings Like These

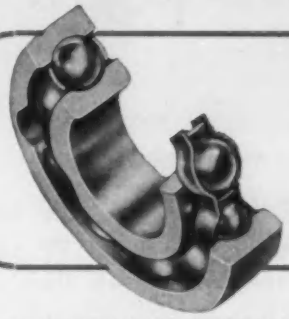


BCA XLS BEARINGS for applications where space is limited

BCA XLS Bearings are especially useful where space is limited and where weight must be held to a minimum—these Conrad type bearings, made to inch boundary specifications, feature a smaller bearing section for a given shaft diameter. They are suitable for any combination of radial and thrust loads. BCA XLS Bearings are used in metal turning machines, earth-moving and other equipment.

BCA 5200 and 5300 SERIES bearings can carry any combination of radial and thrust loads

BCA 5200 and 5300 Series Bearings are double-row bearings of the angular contact, maximum capacity type. The maximum load-carrying capacity is the result of the larger ball size in BCA design. The vertex of the contact angle, between the balls and the raceways, falls within the bearing. This construction insures enough flexibility to compensate for mounting inaccuracies without sacrificing the rigidity required in many double-row bearing applications. These bearings can be furnished with shields and lock ring grooves.

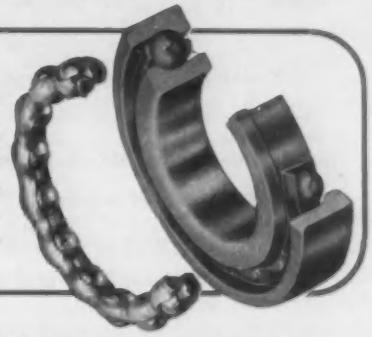


BCA 1200 and 1300 SERIES bearings for HEAVY loads

These BCA maximum capacity type bearings meet the heavy duty requirements of service in farm tractors, road machinery, power shovels, earth-moving equipment, and special materials-handling vehicles. Additional balls are introduced between the raceways thus increasing radial load carrying capacity to a maximum. BCA 1200 and 1300 Series Bearings are made to the same standard metric boundary dimensions as corresponding BCA Conrad type bearings.

BCA ANGULAR CONTACT BEARINGS for maximum performance

BCA Angular Contact Bearings feature a sturdy, one-piece S-section retainer. There are no rivets to work loose, and the design of the retainer permits construction that is fully angular-contact on both outer and inner rings. Low, medium, and high angles of contact are available in both light and medium series bearings. These BCA Bearings have the ability to carry any combination of radial and thrust loads. Thrust loads are taken in one direction only.



BCA engineering cooperation and design assistance are available to help solve your problems involving ball bearings.

BCA AGRICULTURAL BEARINGS save installation and service time

BCA engineers, working with manufacturers of farm equipment, have developed a line of low-cost bearings—pre-lubricated *package units*—designed to save installation time for the equipment manufacturer and service time for the farmer. BCA Cam Follower Bearings, Wheel Bearings, Idler Pulley Assemblies, Flange Bearings, and Hay Rake Bearings already have been proved in use in the equipment of many leading manufacturers.

BCA *radial, thrust, angular-contact Ball Bearings*

BEARINGS COMPANY OF AMERICA
DIVISION OF FEDERAL-MOGUL CORPORATION
LANCASTER • PENNSYLVANIA

for want of a

HUGLOCK NUT

an entire assembly may be lost . . .

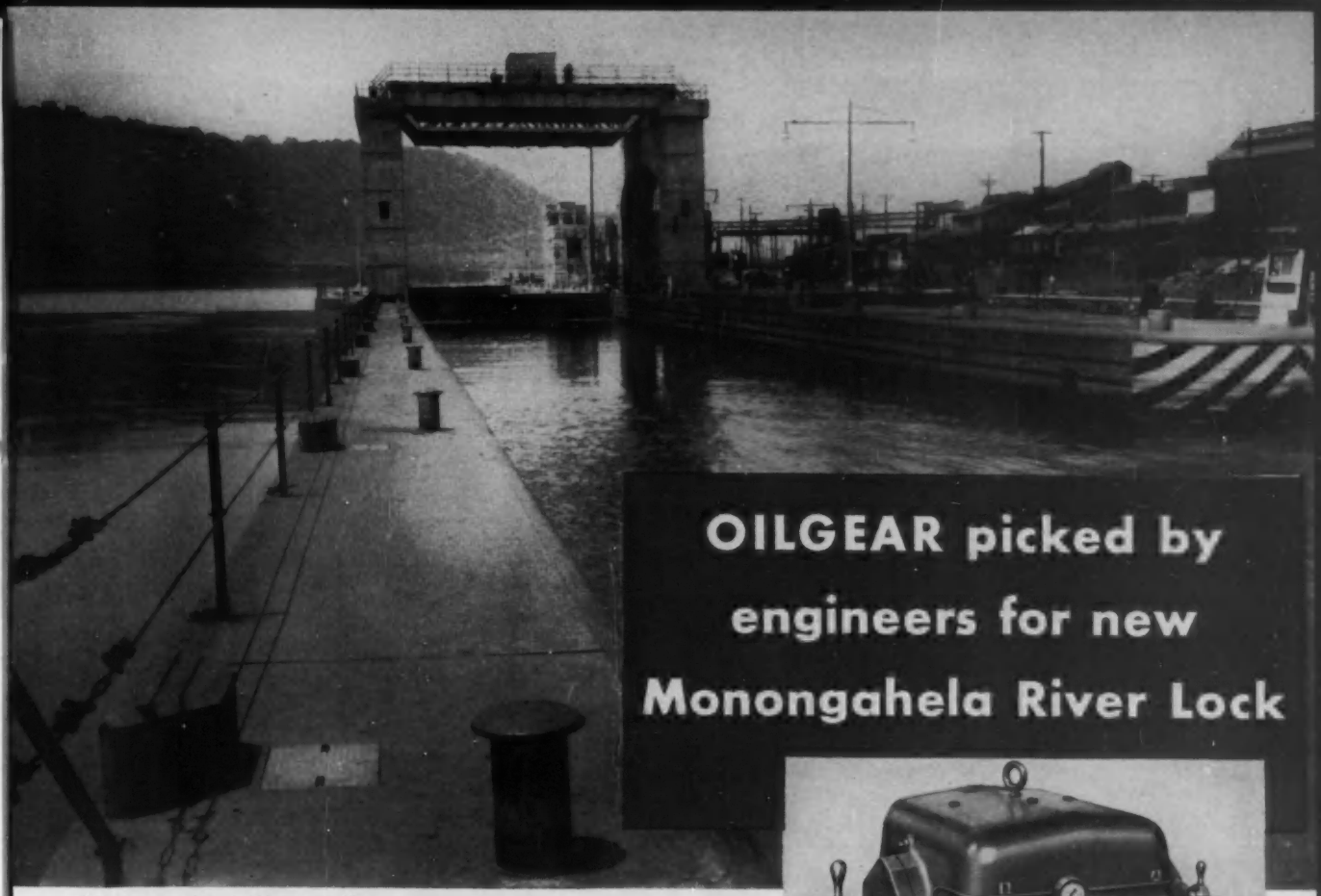
"Use wrench and screwdriver frequently to keep bolts tight"

. . . says Business Week's editor of Personal Business page in a recent issue concerning precautions to be taken in the care of vital household equipment . . . he goes further to say "this insures against strain, breakage of parts, excessive wear." . . . Specify HUGLOCK self-locking nuts in the design of the original equipment and avoid all such waste. . . . The tapered top portion of the nut is slotted to form six threaded segments. These are curved radially inwards to press against the bolt. This creates a heavy inward and downward pressure, producing a friction lock, between the load carrying flanks of the nut and the bolt threads. The combined metal to metal hugging and locking friction is distributed over all of the threads, enabling HUGLOCK to grip the bolt firmly, until removed by a wrench. The HUGLOCK section of our new catalog which is on the press, contains 24 pages. It includes complete information, specifications, engineering data, and prices. It will be furnished upon request. Complete catalog of products may also be supplied if you so indicate.

NATIONAL MACHINE PRODUCTS COMPANY

*Manufacturer of Standard and Special *12 Pointer and Hexagon Nuts . . . "Huglock" and "Marsden" locknuts,*

44251 Utica Rd., UTICA, Michigan



OILGEAR picked by engineers for new Monongahela River Lock

Photo courtesy Corps of Engineers, US Army

This versatile fluid power also used in McNary Dam and Bayou Boeuf Locks

The problem of selecting the power to operate the lock gates, butterfly valves and capstans in the new Monongahela River Lock was to provide the speed of operation, the capacity and the dependability that would keep the rapidly growing volume of shipping on the move. The river at this point now handles millions of tons more annually than Panama.

Certainly, in the fact that Oilgear Fluid Power equipment was selected for this lock, as well as for those at McNary Dam in Oregon, and at Bayou Boeuf in Louisiana, is evidence of the repute in which Oilgear is held.

But we are inclined to stress the *versatility* of Oilgear Fluid Power . . . its applicability to a wide range of needs ranging from the impressive capacity required for lock operation . . . to the delicate and assured precision, controllability and accuracy required in printing on flimsy cellophane . . . and to the middle ground of industry where production must always be increased and always kept on the move.

Fundamentally there is no difference. There must be power, *ample* power, susceptible of control some times rushing and gigantic, some times a mere whisper of power whittled down to a point, as it were.

With Oilgear Fluid Power available in pump and cylinder for straight line motion, or in pump and motor or integrated transmission for rotary motion or reduction of ratio, you have a power source and method applicable to any need. In addition, you gain ability to vary speed or power steplessly in an extremely broad ratio. You can have power that does not move but simply holds a member under constant pressure. You can have speed that clings closely to the changing viscosity of a beaten mass... or power that forms giant airplane fuselages and wings.

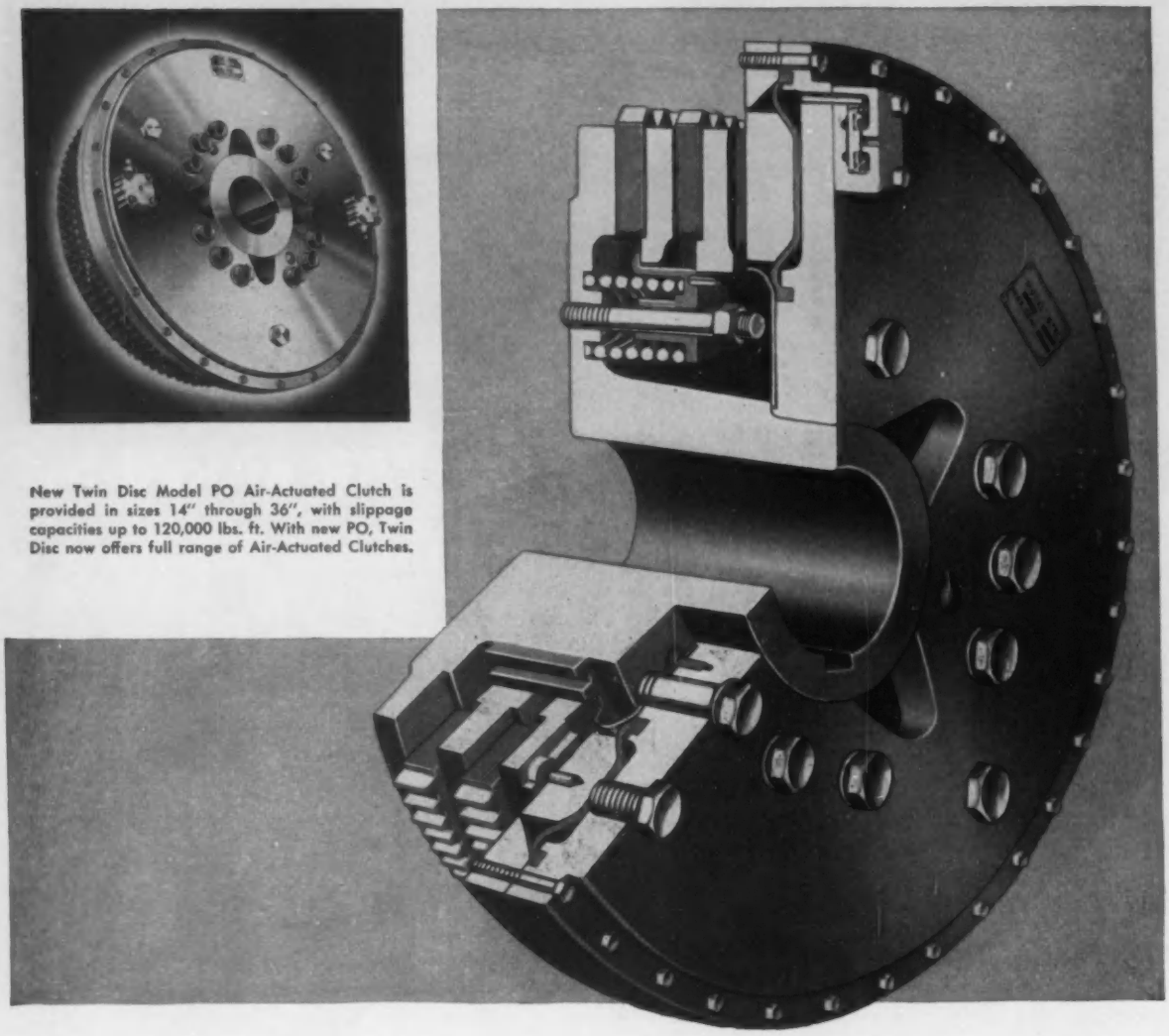
Oilgear Two-way Variable Delivery Pump with Electro-hydraulic Three-position Remote Control.

Whatever your problem, it deserves the opportunity to be matched with Oilgear versatility for a better solution. It will cost you nothing to investigate. It may show you a tremendous gain. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

OILGEAR

PIONEERS . . . SINCE . . . THREE PLANTS FOR FLUID POWER



New Twin Disc Model PO Air-Actuated Clutch is provided in sizes 14" through 36", with slippage capacities up to 120,000 lbs. ft. With new PO, Twin Disc now offers full range of Air-Actuated Clutches.

New Twin Disc Air-Actuated Clutch designs offer higher torque, narrower width, less weight

Lighter, more compact remote control of power transmission without complicated linkage . . . a requirement voiced throughout industry by both the user and the manufacturer of powered equipment . . . and a requirement *met* by the newest addition to the Twin Disc line of Air-Actuated Clutches.

Developed expressly for heavy-duty installations, the new Twin Disc Model PO offers advanced design features with outstanding advantages. Highlighting these advantages are:

1. *Reduced initial installation cost, in many instances, through use of smaller size clutches . . . provided by greater torque capacity.*

2. *Less shock-loading during starting cycles, permitting use of smaller driven components . . . provided by lighter weight which reduces inertia mass.*

3. *More compact installation . . . provided by narrower width . . . permitting the Model PO to be used where, previously, drum or band style clutches with larger diameter and higher inertia were the only solution.*

4. *Faster, smoother operation under all working conditions, with no seal drag.*

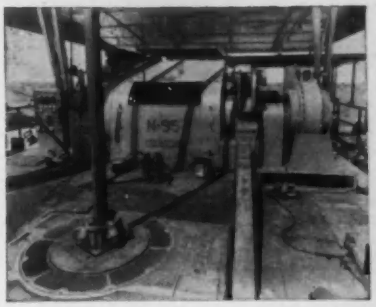
5. *Positive, quick release provided by exclusive Twin Disc diaphragm design — fully-supported, with no-stretch construction—and with extra-long stroke and controlled flexing.*

6. *Long, trouble-free operating life, with extra-large passages from cored back plate providing "air-flow" cooling to the diaphragm insulator plate, springs, and driving plates.*

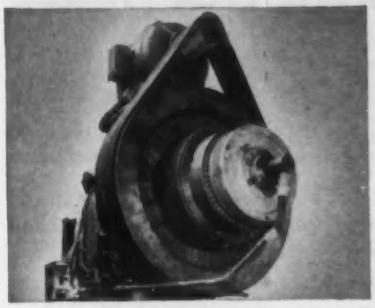
Major economies in servicing have been provided . . . the entire clutch can be stripped to the last piece in less than five minutes . . . and replacement parts are minor components, extremely low in cost. Ideal for all types of heavy industrial machinery . . . cranes, shovels, presses, brakes, hoists, and oilfield equipment.

Write to Twin Disc today for new Bulletin No. 304.

Air-Actuated Clutches prove adaptability in variety of industries . . .



For greater efficiency and longer working life, the new Brewster N-95 Drawworks standardizes on Twin Disc Model PO as working clutches, with a 3-plate 30" on the low drum, 2-plate 30" on high drum, and 3-plate 24" as master clutch.



A Twin Disc Air-Actuated Clutch provides remote control and smooth engagements for this Ferracute 75-ton Press — plus higher capacity, less weight and lower inertia which permits operation speeds to be increased 100% on short strokes.

TWIN DISC

TWIN DISC

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

by Design

BIJUR

AUTOMATICALLY ASSURES CUSTOMER SATISFACTION

the user of your machines

- Increases Productive Capacity
- Saves on Repair Bills
- Eliminates Costly Hand Oiling
- Reduces Downtime
- Lengthens Machine Life

WITH Bijur Automatic Lubrication as an integral part of your equipment, your customers benefit from continuous peak production. Plant after plant reports increased out-put and greatly reduced maintenance costs with Bijur-equipped machines. Costly downtime for lubricating by hand is eliminated. Every bearing is metered the proper quantity of oil at predetermined intervals. Work spoilage and bearing troubles caused by over-lubrication are avoided. Fire hazards are reduced. Personnel accidents are prevented.

Bijur gives you the opportunity to add customer satisfaction through improved machine performance.

More than a million Bijur-protected machines are in use. Hundreds of leading manufacturers standardize on Bijur as "built-in" components of their machines. Bijur emphasizes custom-engineering, and we will gladly cooperate in designing a system to meet the specific requirements of your machine.

Design Bijur into your machines now in production or in the planning stage. Write for literature and engineering information.

C-3

2369

BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

New Taylor laminates

are premium in everything but price

YOU'LL LIKE everything about this new family of Taylor paper-base laminates—including their price. They're a new kind of hot-punch laminate, uniform all the way through, with no surface overlay of resin.

In insulation resistance, water absorption, power factor, flame retardance and dimensional stability, they'll meet or exceed your strictest specifications. And they punch and stake so well . . . with smooth surfaces and clean edges . . . that you can produce complex parts with maximum utilization of each sheet.

Four different grades are available in production quantities, in standard sheet size of approximately 49″ by 49″:

XXXP-301 . . . *the top grade laminate* with unusually high insulation resistance, lowest water absorption . . . excellent punching and staking.

XXP-351 . . . a high grade laminate with most of the properties of XXXP-301, at lower price.

Grade 353 . . . a quality grade laminate priced for economy, with outstanding electrical and physical properties.

Grade 354 . . . an easily fabricated grade having low water absorption and good stability . . . priced for real savings.

Taylor Fibre Co. Plants in Norristown, Pa.; and La Verne, Calif. *Branch offices in Atlanta; Boston; Chicago; Cleveland; Dayton; Detroit; Indianapolis; Los Angeles; Milwaukee; New York City; Philadelphia; Rochester; San Francisco; St. Louis; and Tolland, Connecticut. Distributors in Grand Prairie and Houston, Texas; Jacksonville, Florida; New Orleans, Louisiana; and Toronto, Ontario.*

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TAYLOR
Laminated Plastics
Vulcanized Fibre

TO GET ALL THE PERFORMANCE DESIGNED INTO YOUR PRODUCT

Choose Century MOTORS

From the Wide Range of Types of

In Sizes From 1/8 to 400 Horsepower

SINGLE PHASE:

Split Phase Induction—⅛, ¼, ½ H.P.

Capacitor—⅛ to 20 H.P.
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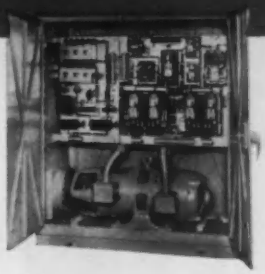

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A complete line of adjustable speed drives for coordinating all kinds of production processes.

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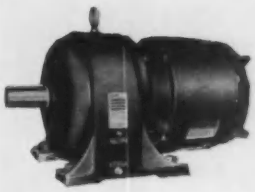

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All capacities—⅛ to 300 H.P.
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GENERATORS:

AC, .63 to 250 KVA
DC, .75 to 200 KW

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Motors listed above are available in Open Rated Drip Proof, Splash Proof, Totally Enclosed Fan Cooled and Explosion Proof frames—and with a dozen different methods of mounting. They are unusually quiet starting and running and unusually free from vibration.

878

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The saving results from elimination of one production operation, without loss of mechanical values. The difference is in appearance. And even that may be in favor of the recessed head.

To order only, made to standard dimensions in sizes to suit your needs or to your specifications.

Get our prices and deliveries on your requirements. In fact write us about special upset, and rolled thread products of any kind. The cost may be lower than you think.

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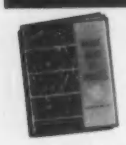

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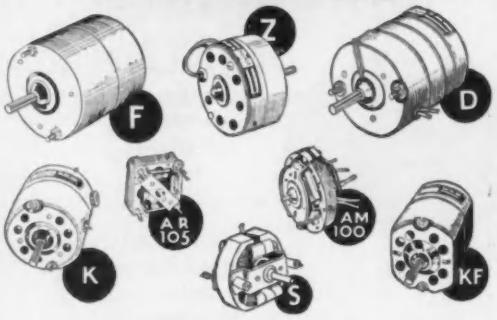
SUB-FRACTIONAL HORSEPOWER MOTORS



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All described in the Heinze catalog.

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SHAFT SIZE REDUCED from 1½" to 1¼"

BY USING **HIGH-STRENGTH GROUND AND POLISHED**

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INSTEAD OF C1045

The UNI-HARVESTOR is really different. It harvests grains, beans, and all seeds—it picks and husks corn, and bales or chops hay. Ground and Polished STRESSPROOF is specified for the cylinder shaft.

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STRESSPROOF is a severely cold-worked, furnace-treated, carbon steel bar with a unique combination of four qualities in the bar: (1) Strength, (2) Wearability, (3) Machinability, and (4) Minimum Warpage. Yet it costs less than other quality cold-finished steel bars. Available in cold-drawn or ground and polished finish.

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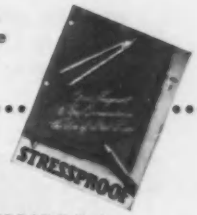

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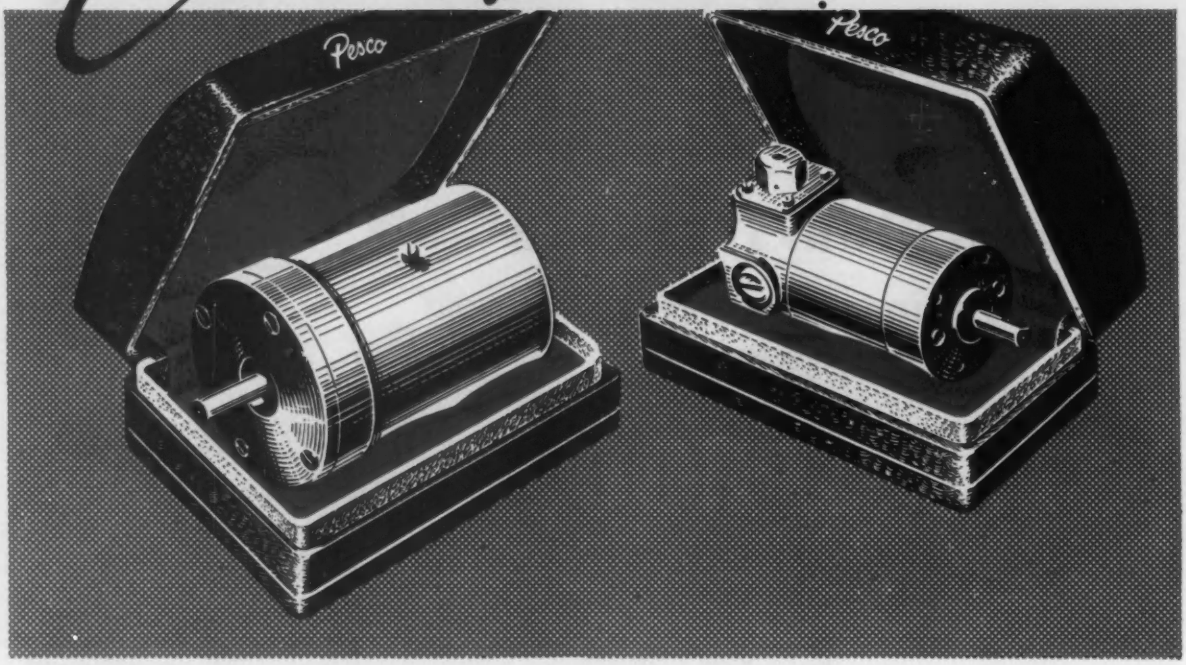

*WITH STANDARDIZED PARTS

Pesco "coordinated-frame" electric motors provide you with several important advantages.

First, they provide maximum power packaged in a minimum-sized unit to meet every installation and operating requirement from .01 to 11.0 horsepower.

Second, by using standardized Pesco parts in a series of coordinated frame sizes, Pesco lowers unit cost and greatly simplifies the stocking of service parts.

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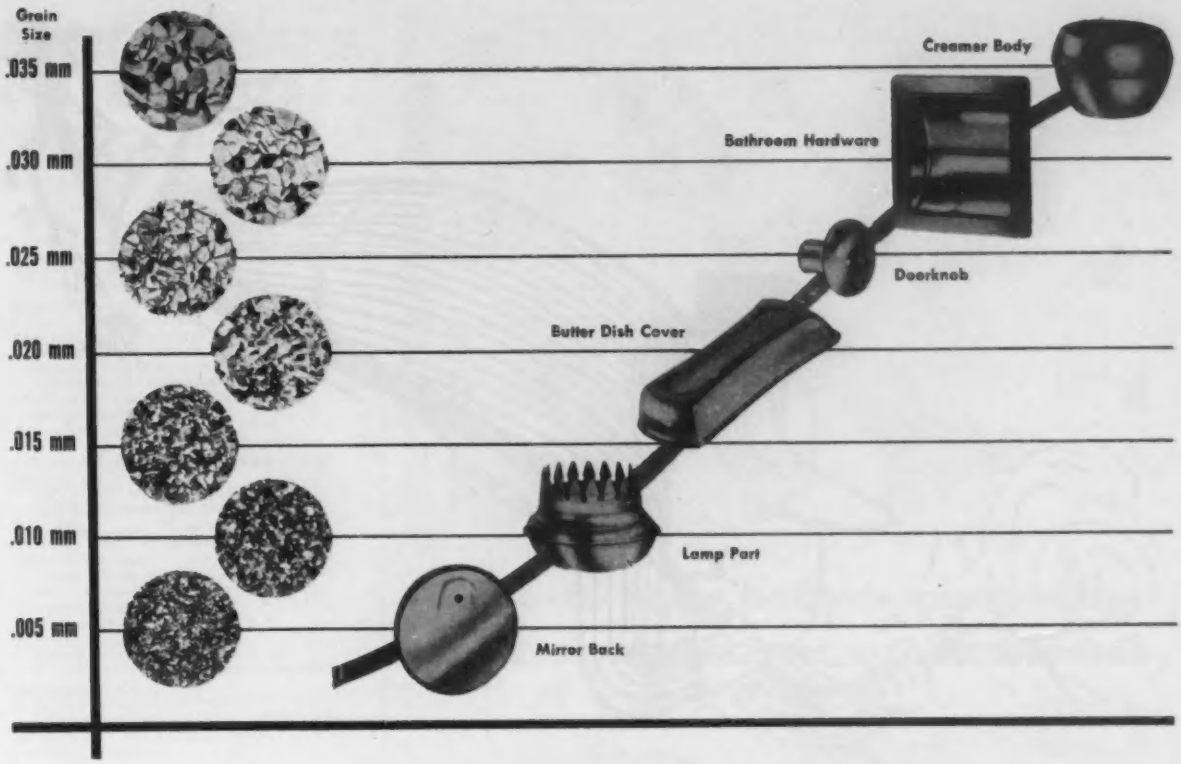

Which is the RIGHT Fine Grain Brass for a Job?

Write for a free copy of Bridgeport's folder on Grain Size— "The Fourth Dimension."

High finish on decorative brass can be produced at much lower cost by using a fine grain metal. But severe cupping, drawing and forming operations require ductility which decreases, generally, as grain size gets finer.

The right metal for the job, then, is often a compromise between fineness of grain and ductility: *no one fine grain brass can do all jobs well.*

By offering a *range* of grain sizes, Bridgeport can supply you with the *right* fine grain brass for every application, assuring you optimum production at lowest costs.

Bridgeport Technical Service will be glad to work with you in finding the right brass for your product if you will contact them through your local Bridgeport Sales Office.

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Serving Industry With a Nationwide Network of Conveniently Located Sales Offices and Warehouses
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Your Kaiser Aluminum Distributor will!

HE'S GEARED to meet your emergency needs, to go to work for you the minute you call. From his large stocks of aluminum, he'll quickly provide you with almost any size, shape or alloy.

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All these services mean more profits for you because they help lower your costs. Why not call your Kaiser Aluminum Distributor today?

IMPORTANT MESSAGE FOR SCREW MACHINE SHOPS

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Kaiser Aluminum

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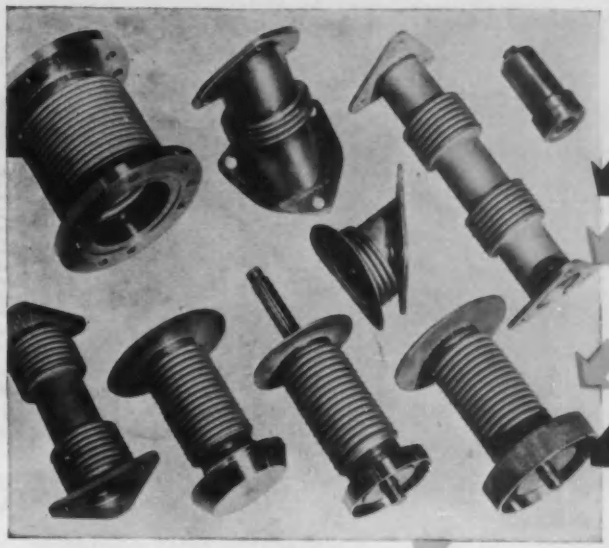

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Our specialty is building precision bellows assemblies of stainless steel and other metals. We can build them faster, better and at low cost — to your specifications.

If you work with devices to provide precision control of temperature, pressure, expansion, hydraulic fluids, Sylphon or Bridgeport bellows assemblies may help you cut costs, speed production and improve performance.

We have an interesting booklet for you that spells out some of our services and tells about the many types of bellows assemblies we can make. Just ask for XP-1400.

And, if you have a special application coming up, why not check into our services? Our bellows engineers will gladly cooperate in the design, application, and testing stages of your project. This alone will save your own engineering and testing time.

Bellows engineers such as **D. H. Overhiser** *are ready at a moment's notice to go anywhere to tackle any bellows design problem.*

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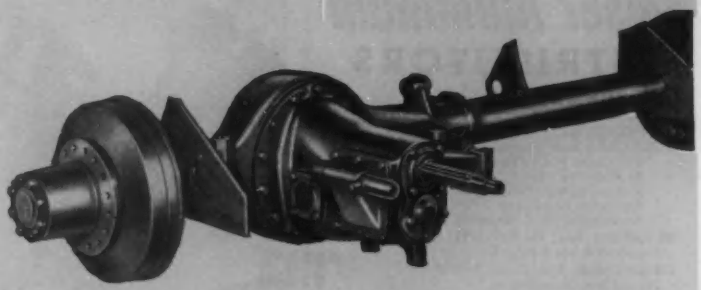

NO SINGLE DESIGN

Whether your axle-transmission drive problem is for industrial or agricultural equipment—whether it's for a highway, or an off-highway vehicle—you can find a solution at Clark.

Clark Drive Units are all designed to meet a specific need —to solve a definite problem.

For more than a quarter of a century Clark engineers have been working with industry engineers to help *them* design transmission and drive units that add to utility, ease of operation, long life and dependable performance.

That's why IT'S ALWAYS GOOD BUSINESS TO DO BUSINESS WITH CLARK.

CLARK EQUIPMENT COMPANY
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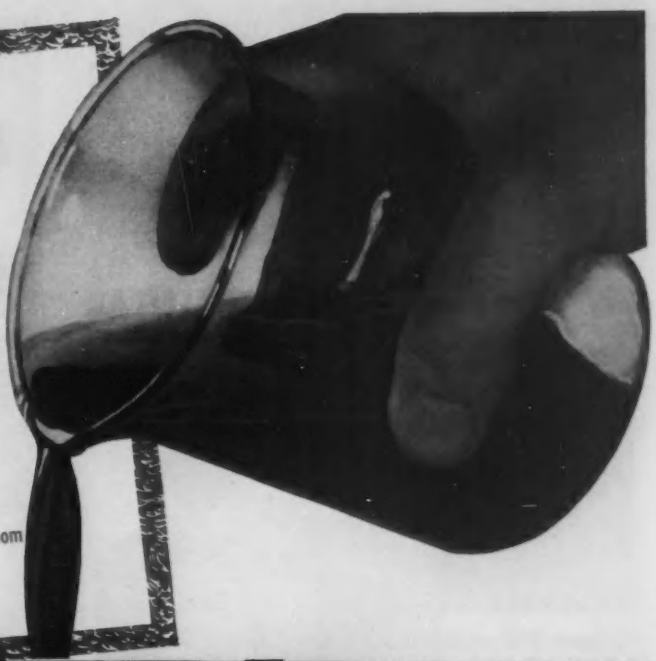
® TRADEMARK OF THE CLARK EQUIPMENT COMPANY

Elastomeric Seals with Top Performance from *Thiokol*® Liquid Polymer

A solventless liquid that converts to a rubber at room temperature without shrinkage



Many sealing problems encountered in equipment construction can be solved by making use of one or more of the following properties developed by elastomeric sealers based on "Thiokol" Liquid Polymer:

- Adhesion to a wide variety of metallic and non-metallic materials
- Resistance to attack by oils, solvents, water, salt spray, mild acids and alkalies
- Inertness to ozone, sunlight and aging
- Good electrical properties
- Impermeability to gases and moisture
- Seal retention under severe temperature cycling, vibration and mechanical shock

Some of the applications using these properties are deck caulking, potting electrical connectors and sealing airplane fuel tanks. "Thiokol" Liquid Polymer was chosen as the sealer base because of its processing characteristics and physical properties. It is a fluid material that can be flowed or pressure-fed into place. On curing at room temperature it converts entirely to a resilient rubber with an unusual combination of desirable sealer properties.

Sealers based on "Thiokol" Liquid Polymer are used in many industries. They yield top performance in all applications.

Perhaps sealers of this type may help you meet a difficult processing and performance requirement. Write for technical information and samples.

Thiokol Chemical Corporation supplies "Thiokol" Liquid Polymer only as a raw material. We will gladly indicate sources of supply to end-users.

SYNTHETIC RUBBERS
PLASTICIZERS
CHEMICALS
SOLID PROPELLANTS

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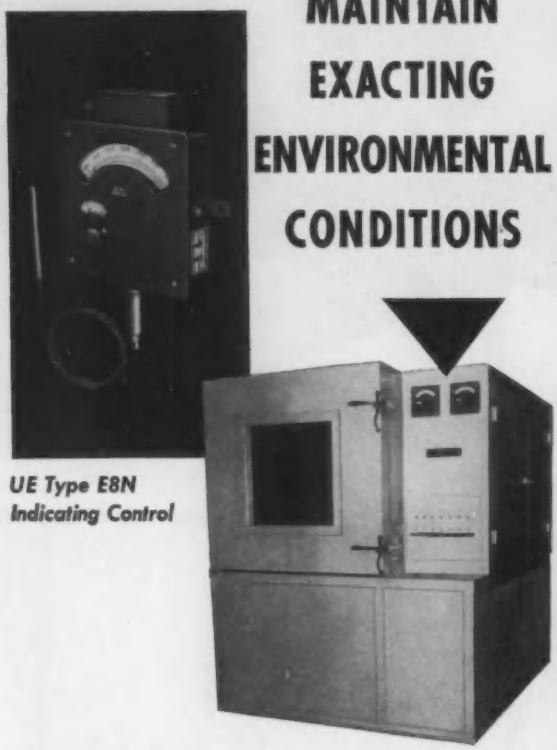
INDICATING CONTROLS MAINTAIN EXACTING ENVIRONMENTAL CONDITIONS



UE Type E8N Indicating Control

The temperature-humidity chambers made by Tenney Engineering, Inc., are widely used in testing resistance to moisture and corrosion, and in determining durability. They are also used in observing animal and plant life for changes caused by climatic conditions.

In these units, two United Electric Type E8N Indicating Controls accurately indicate and maintain simulated climatic conditions over wide temperature ranges. By simply resetting these controls, a new atmospheric equilibrium can be established in the chambers within 10 to 15 minutes.

United Electric manufactures many other temperature and pressure controls for use on environmental test chambers as well as for such varied applications as oil refinery and pipe line machinery, turbines and engines, aircraft, ovens and air conditioning equipment.

Special controls can either be adapted from standard models, or custom-built by United engineers working in cooperation with your own product development engineers.

Write today for information on the complete line of United Electric controls.

Standard and special temperature and pressure controls

UNITED ELECTRIC CONTROLS CO.
87 School Street, Watertown, Mass.

ABBOTT

For **LOWER COSTS**
Use **the BALL with the ARMORED HEART***

- It's ADAPTABLE to many applications.
- It's PRECISION MADE and held to tolerances of .0001 inches.
- It's DEPENDABLE and performs efficiently under the most demanding conditions.
- It's PERFECTLY PACKAGED to prevent loss and contamination in shipment or storage.

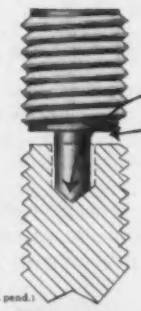
IT'S A THRIFTY HABIT TO ASK FOR ABBOTT . . . the Ball with the Armored Heart.

* Only Abbott makes the Ball with the Armored Heart—the carbon steel bearing ball which is DEEP HARDENED and TEMPERED for maximum life, shock resistance and load-carrying ability.

ABBOTT

THE ABBOTT BALL COMPANY
55 Railroad Place, Hartford 10, Conn.

SETKO Announces New
Pivot-Lok Set Screws

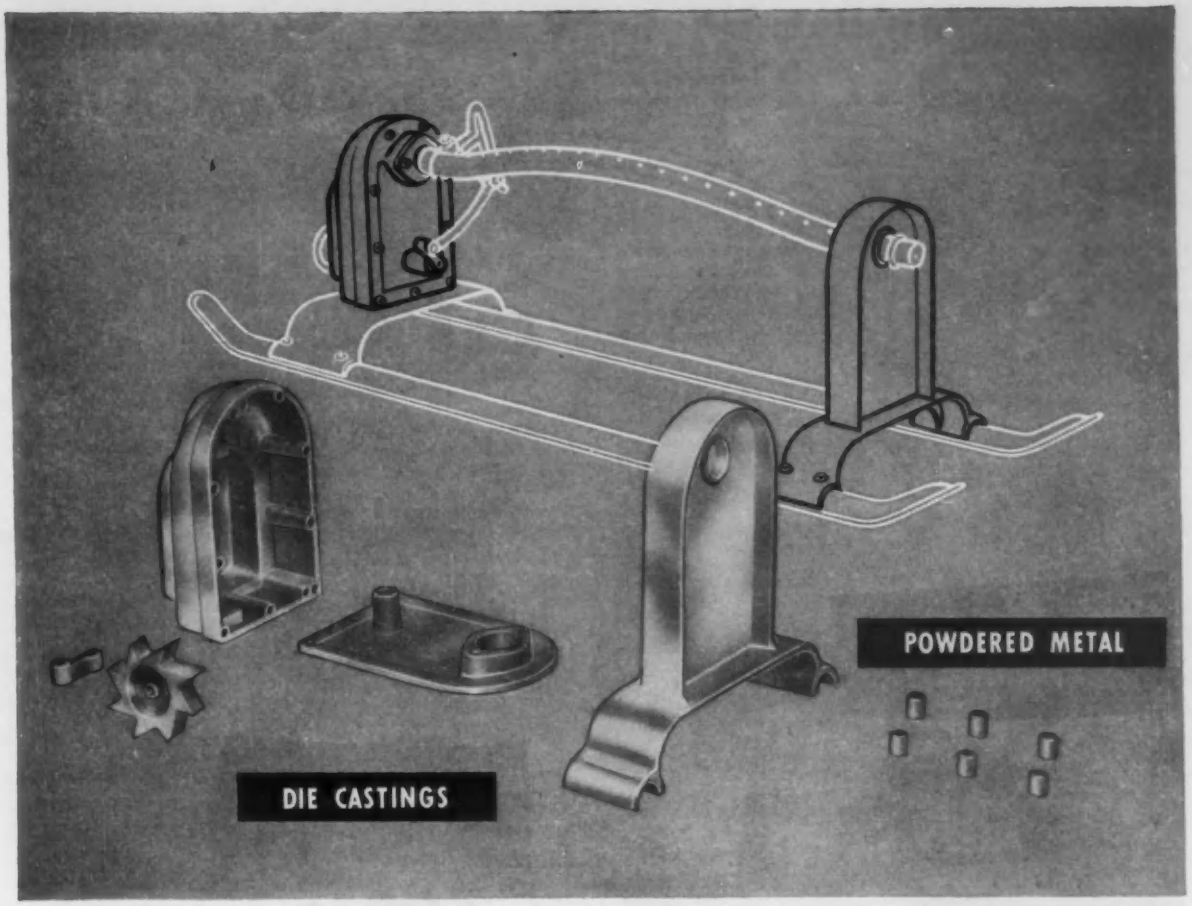


(pat. pend.)

For jobs using two screws for security purposes, or where vibration is a factor.

Pivot on top screw acts as a bearing. Pivot avoids friction between the two screws and prevents damage to the lower socket. Pivot screw can be furnished with any type of self-locking thread such as Zip-Grip, Off-Set, etc. Provides positive holding action, but both screws easily removed when desired. Send for new illustrated bulletin giving full data.

Set Screw & Mfg. Co.
153 Main St., Bartlett, Ill. (Chicago Suburb)
We Specialize in Solving Puzzling Set Screw Problems



PARKER USES 2 MEANS TO 1 *Lower Cost* END

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Low cost—consistent with high quality—was the primary objective in producing important component parts for the popular lawn sprinkler made by Eastern Machine Products Inc. Parker gained this objective by making the end bracket, actuator housing, crank, and water wheel of aluminum die castings. The bushings inside the housing are bronze alloy sintered metal. The end result: component parts that meet every specification at lower cost.

This example emphasizes an important point about Parker service. No matter what your requirements in either die castings or powdered metal, Parker has the skill, experience and facilities to provide either or both. This undivided responsibility has saved money—and solved problems—for many users. Your problem may be one that Parker can solve in like manner. Just call the nearest Parker sales engineer listed at the left.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER **ALUMINUM and ZINC *die castings***

STRENGTH WITHOUT BULK

The exceptional tensile and torsional strength of Mac-it Screws makes it possible to use smaller, lower cost screws for all fastening jobs. Mac-it Special Alloy Steel used in all Mac-it Screws is held to rigid specifications, assuring uniform and dependable screw fasteners.

PRECISION FASTENERS

The precision manufacture and quality control used in making Mac-it Screws provide users with high dimensional accuracy and uniformity. All Mac-it Screws in both coarse and fine threads are held to a class-3 fit.

MAC-IT SCREW ENGINEERING

Mac-it maintains a fastener engineering service for the design, development and production of screws to suit all types of applications.

SPECIFY **Mac-it** ® FOR ALL THESE ADVANTAGES

ONE MAC-IT CALL GETS 'EM ALL!

SPECIAL SCREW PRODUCTS

Mac-it is geared for either large or small run production of screws with special design or strength characteristics.

HEAT-TREATING

Mac-it heat-treatment is more than a mere case hardening or surface processing. The high quality of Mac-it Special Alloy Steel adapts it to heat-treatment that penetrates throughout the structure of the screw so that the center possesses the same sturdy toughness possessed by the outside. Proved formulas govern this process.

Each type Mac-it Screw is heat-treated to possess maximum strength for the particular purpose for which it is to be used. No one heat-treatment is best for all purposes.

DISTRIBUTOR SERVICE

Contact any of the hundreds of Mac-it distributors from coast to coast for immediate service to supply your requirements for standard or special screws.

MAC-IT SCREW DEPARTMENT

STRONG, CARLISLE & HAMMOND COMPANY

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Manufactured by Mac-it Parts Co., Lancaster, Pa.

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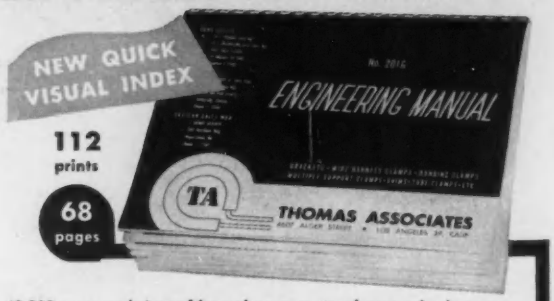

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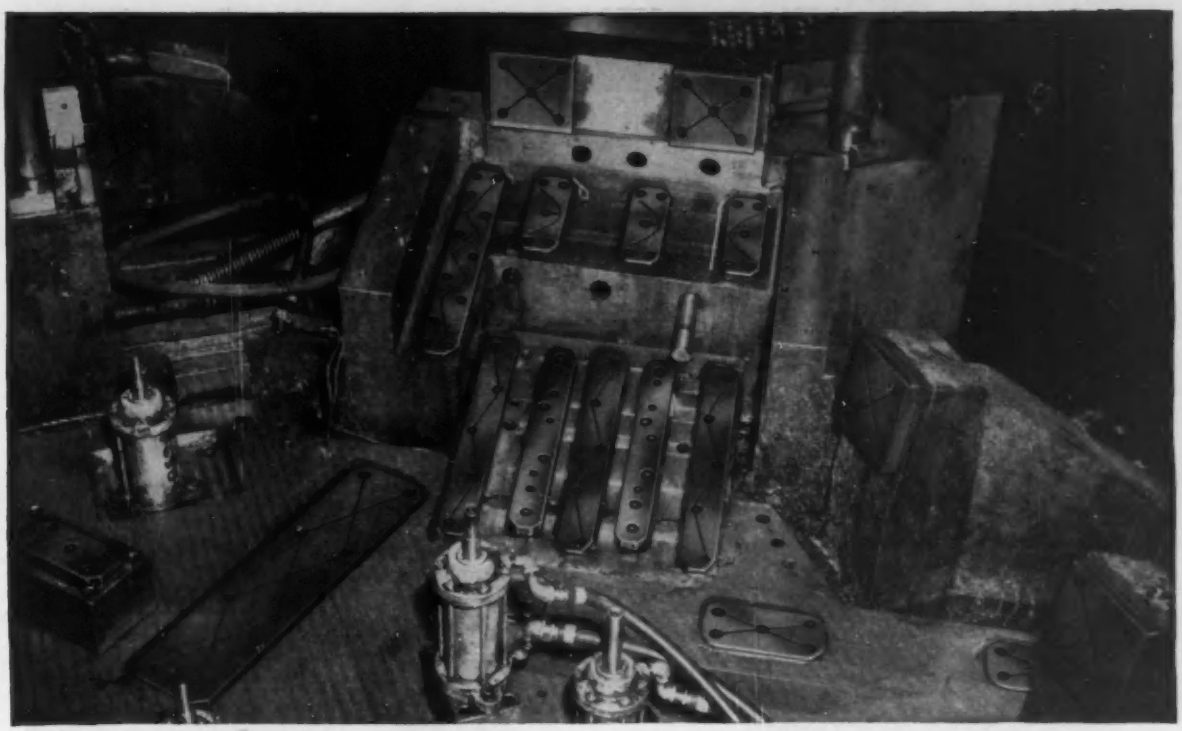

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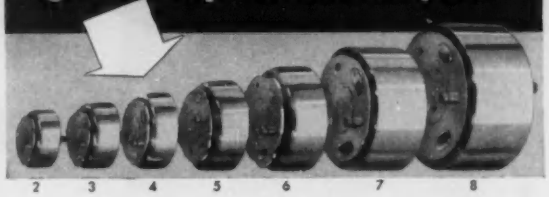

Now, with the addition of the new model BD4, Ledex Rotary Solenoids are available in seven basic sizes with various degrees of rotation and torque values up to 54 pound-inches. This new BD4 model offers the same compactness, ruggedness, versatility and dependable snap action as all the previously available sizes of Ledex.

Torque values for normal intermittent duty and 45° stroke.

Model No.	2	3	4	5	6	7	8
Diameter inches	1 1/8	1 5/16	1 9/16	1 7/8	2 1/4	2 3/4	3 3/8
Torque lbs.-inches	.4	1.0	1.7	4.0	7.5	25.0	54.0

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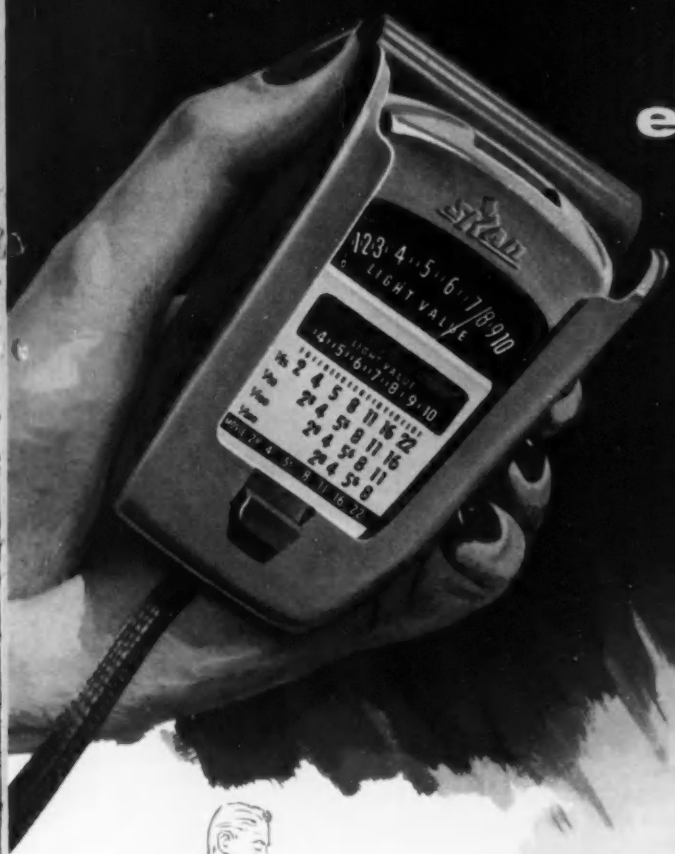
New plastic exposure meter carrying case clicks with photographers



ACTUAL SIZE

There's something brand new in the photography picture—a polyethylene carrying case for the SKAN "Quick" exposure meter. Polyethylene was the natural choice of Continental's plastic designers because it's warm and smooth to the touch and as highly resilient as the finest leather. It resists tearing and cracking, too; and high style can be molded right into it.

The new Skan case is one piece, with no zipper, snaps or buckles—nothing to break off, lose, wear out or get out of adjustment. The meter fits snugly in its cushioned case, ready for instant reading. Photographers love it.

Continental is an old hand at applying plastics to product problems. Like artists, our designers work with a full palette of colors, types and properties. Have you ever thought of your product in plastic? Why not? Talk it over with Continental.

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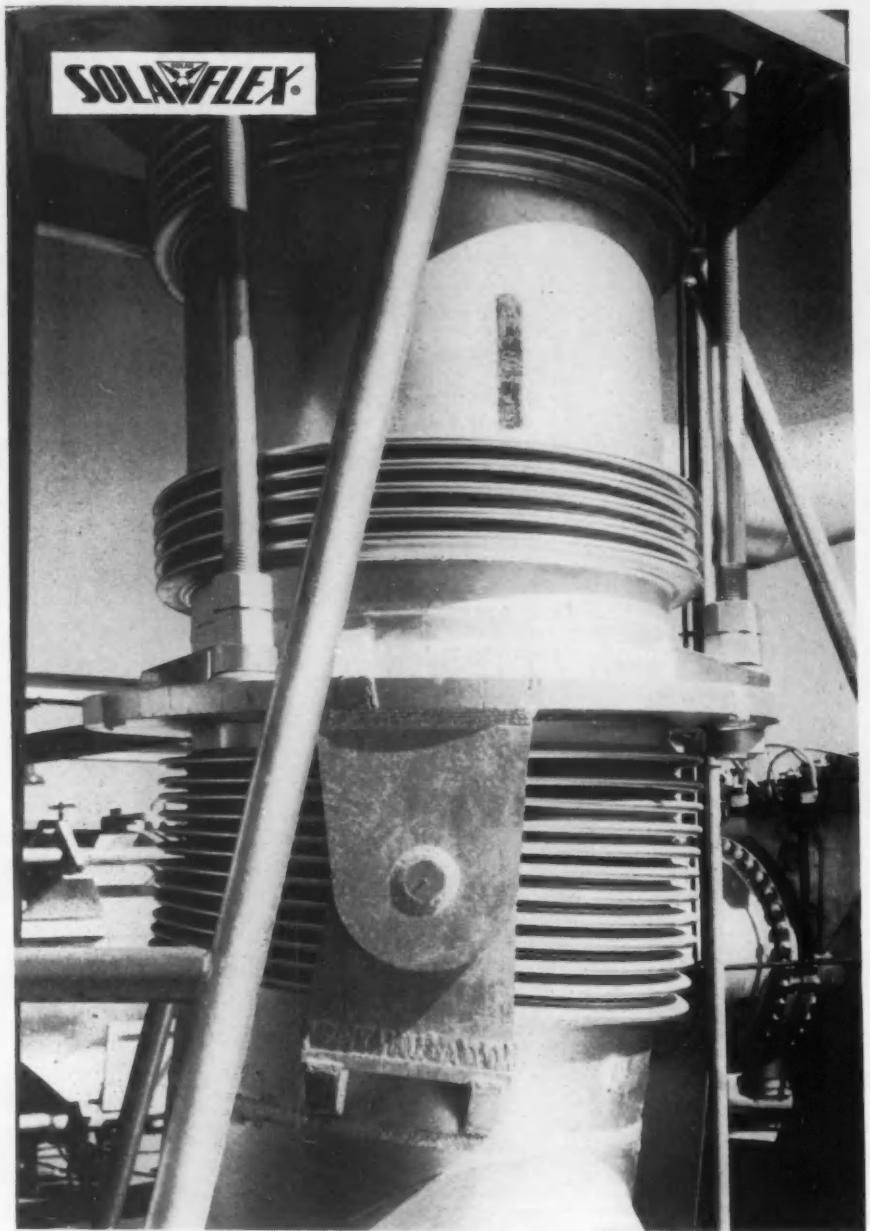

Marquardt Aircraft Company photo

A "hinge" for hot air

THE SOLA-FLEX BELLOWS shown above give flexibility to a 36 inch hot air line in a facility for engine testing. Operating at temperatures up to 650 F and pressures ranging to 150 psi, this Solar-built expansion joint allows both angular and lateral movement of the piping while conducting huge blasts of air.

This application of Sola-Flex bellows is unusual – yet typical of the varied design and production problems solved by Solar. Use of Sola-Flex expansion joints and convoluted couplings is growing rapidly in the oil, power, chemical, and aircraft industries.

Consult a Solar engineer, or send for Sola-Flex catalogs, if your piping problems call for a "hinge"!

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PLANTS. *In San Diego and Des Moines (photograph above). A total of 1,400,000 sq ft of floor space. Approximately 5,000 employees. Annual sales over $65,000,000.*

EQUIPMENT. *Production equipment for all types of metal fabrication —forming, machining, welding, brazing, casting, coating. Extensive laboratory and testing equipment. Facilities for development, prototype, limited or mass production.*

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Bellows. *"Sola-Flex"® bellows and expansion joints in many designs from ½ in. up to the world's largest, 28 ft in diameter.*

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Controls. *Complete control systems utilizing the new Solar "Microjet"® principle for control of gas turbines, jet engines and pneumatic devices.*

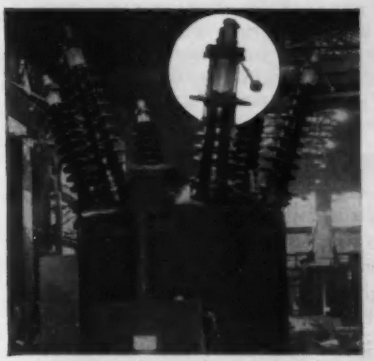
FURTHER INFORMATION
Your inquiry regarding any Solar product or service will receive prompt attention. Address Solar Aircraft Company
Department A-48
San Diego 12, California

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Sunglasses for circuit breakers. If you were responsible for the health of a battery of big outdoor circuit breakers, you'd be pretty careful about maintaining the dielectric strength of the oil which is used in them.

Exposure to too much sunlight tends to cause this oil to deteriorate and undermine its dielectric strength. So Canadian Westinghouse Co., Ltd. fits circuit breakers for outdoor use with "sunglasses" on the only part where the sun can get at the oil—out near the tips of the bushings that project like horns from the breaker tank.



Actually these "sunglasses" are oil gauges, but they're made of low actinic glass and it's the "low actinic" that keeps harmful rays from sapping the strength of the oil. Here's how this glass tames wayward angstroms:

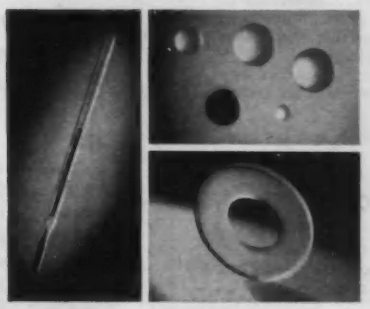
Wave length (Angstrom Units)	Percent Transmission
3000	0
4000	1
5000	4

Low actinic is just one of many special glasses Corning has developed for handling problems of radiant energy. Not only the sun's rays but rays of all kinds—from cosmic to infrared, from X- to radio—find a formidable opponent in glass.

▶ If you're interested in details, we have them for you. Just write us for our *color filter catalog*. It's full of information on how to stop some wave lengths and let others go by. Or we'll be glad to have a look at your own special ray-control problem, if you like. Our researchers are better than fair-to-middling at turning problem rays into rays of hope.

On non-human tolerance. Tolerance has a sort of chameleon-like aspect: in humans we want it broad and generous (Ralph Waldo Emerson has worked that one over pretty thoroughly); in engineering materials we often want it the opposite—narrow and close. (We'd like to work *this* one over briefly, because it's one of the things glass has that may interest you.)

Take the bore in thermometer tubing, for instance—the hole the



mercury works in. It's often so small you couldn't force even a split human hair into it. But, even when we extrude it in mile-long lengths, we hold it to that dimension within a tolerance of ±.0003″.

And the glass jewel bearings which delicate instruments like potentiometers use—they're made from rods accurate to a tolerance of .0235″. We make the rods. The instrument manufacturer buys them and makes the bearings—and gets a bonus, too, because he doesn't have to final polish them with abrasives. This saves time and money.

The glass rotary sealing rings shown above are part of an almost all-glass chemical pump. They keep liquids from leaking out when the pump's in action, which means they must fit tighter than tight. We make them to ±.0005″ tolerance. And we make them of VYCOR brand 96% silica glass which maintains its dimensional stability, resists acid corrosion like no other commercial material we know of, and stands the thermal shock that develops if the pump runs dry.

▶ If you'd like more on the tolerances you can hold glass to, on its ease of processing and its thermal and physical strength, the next paragraphs tell you about two books that are good reading.

Good reading, if . . . If you know an engineer who's hungering for some really technical information about this complex material called glass, you might recommend adding a couple of brass-tack bulletins to his bill of fare.

One of them condenses into fourteen pages a whale of a lot of useful information on mechanical and electrical properties, thermal stresses, heat transmission, corrosion resistance, viscosity, and other measurable attributes of PYREX, CORNING, and VYCOR brand glasses. We file it as Bulletin B-83; its more imposing title is "Properties of Selected Glasses."

The other one is Bulletin B-84—"Manufacture and Design of Commercial Glassware." It talks about glass melting. It describes the problems and limitations of designing blown glassware and pressed glassware. It gives forth on annealing and tempering, hole drilling, sealing components together, metallizing, assembling glass and metal, and other useful subjects.

▶ Neither of these booklets is the kind your engineer friend will curl up in bed with, but both can contribute to his understanding and profitable use of glass as the versatile and often surprisingly talented design and engineering material it is. We'll be glad to send you, or him, or both of you, copies.

We offer *carte blanche* service. If sun, nor reading, nor tolerances aren't currently weighing you down, let's put our heads together over whatever materials or processing problem may be specific with you right now. Could be glass has something to offer. If it has, we'll be delighted to expound at pertinent length. If it hasn't, downhearted as we'll be, we'll tell you so. May we hear from you?

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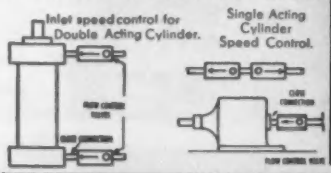

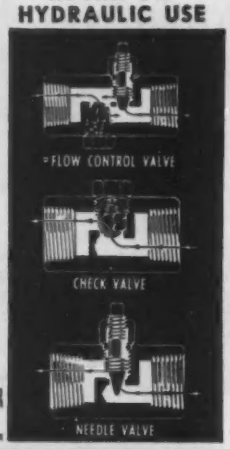

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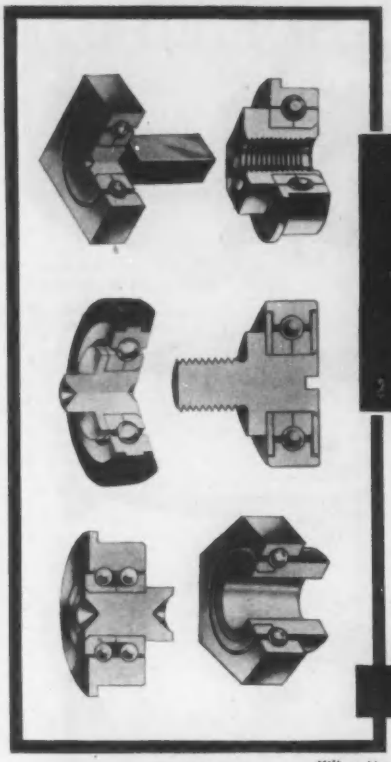

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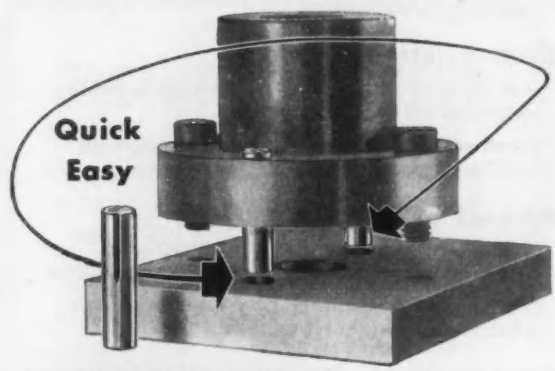

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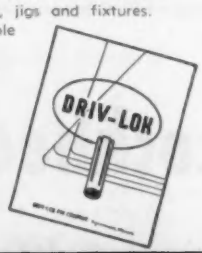

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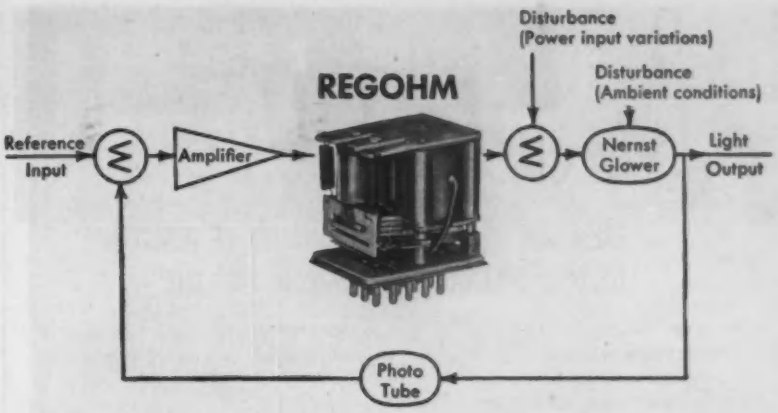

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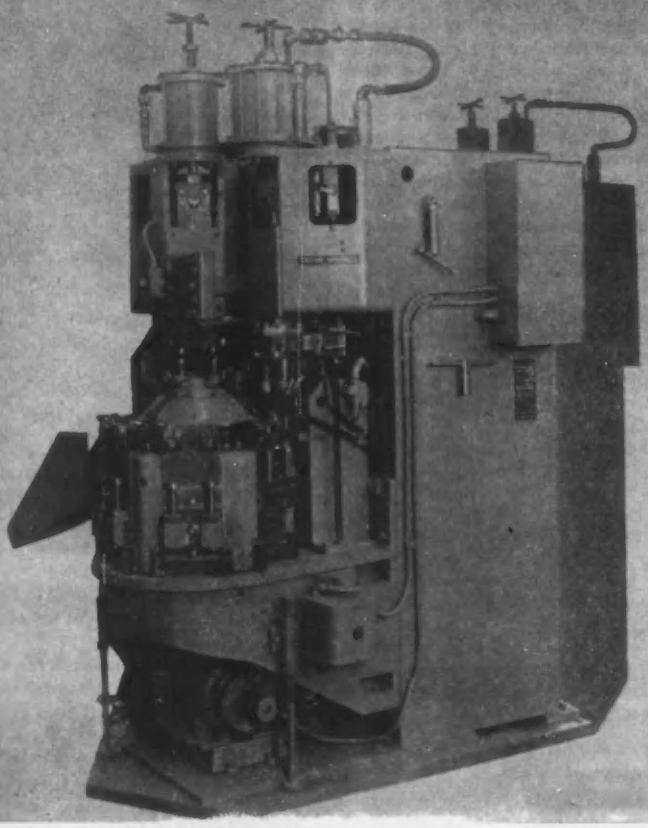

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September 17, 1954

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22—High-Speed Mechanical Counter
23—Valve With Universal Outlets
24—Small Die-Cast Counters
25—Seal Simplifies Actuator Design
26—Equipment Pull Handles
27—Sliding Latch Pulls Panels Tight
28—Nut for Conduit and Fittings
29—Silencer Doubles As A Manifold
30—Automatic Air Line Moisture Unit
31—Quick Connect-Disconnect Coupling
32—Coupling for Pressure and Vacuum
33—Self-Tapping Set Screws
34—Free-Spinning, Reusable Locknut
35—Fittings Flare Tubing
36—Positive Break-Away Hose Coupler
37—Threaded 45 deg Angle Connectors
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39—Single-Phase Capacitor Motor
40—Automatic Control for Vibrators
41—Fan-Cooled, Wound-Rotor Motor
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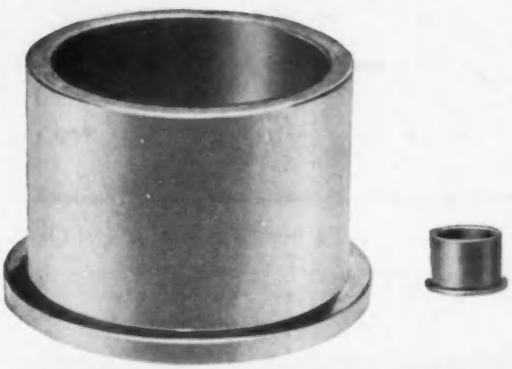

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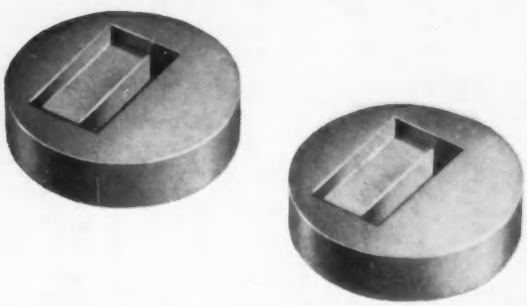

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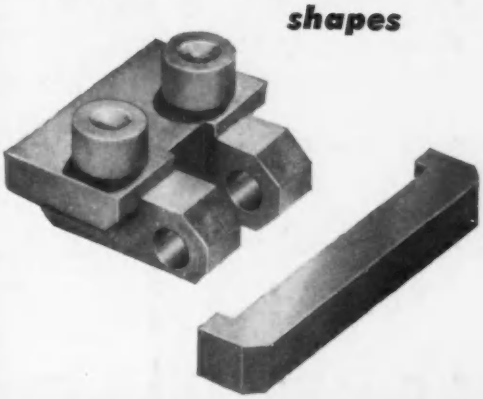

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